Early Clinical and Echocardiographic Effects of Elective Percutaneous Coronary Intervention

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Abstract: Early effect of elective percutaneous coronary intervention (PCI) is important in clinical practice. Knowledge of different variables for suboptimal effects of PCI may help to refine indications of and to guide strategies aimed at improving outcome. Objectives. To detect the early effects of elective PCI on different clinical and echocardiographic variables in the studied group and in different patient subgroups. Methods. Twenty-four patients with established coronary artery disease who are candidates for elective PCI of one or more of coronary vessels were enrolled in the study after exclusion of pts with acute MI and any contraindication for coronary angiography. After obtaining complete history and full clinical examination; every pt was subjected to *clinical assessment* using Minnesota questionnaire & Canadian Cardiovascular Society Angina Classification (CCSAC), *transthorasic echocardiographic examination* with measuring of the following: Left ventricular end-diastolic and end-systolic volumes (LVEDV & LVEDV) with calculation of LV ejection fraction (LVEF), 17 segment model scoring system, wall motion score index (WMSI) & Myocardial performance index (MPI). *Elective coronary angiography* was performed with implantation of one or more stents. Clinical assessement and echocardiographic parameters were reevaluated 1 month post PCI. Analysis of data was done in the studied population & in pts subgroups according to risk factors, medications type, lesion classifications, type of revascularization, stent type and number of vessel affected. Results. 24 pts; 17 males & 7 females with mean age 55.7±9.3 years were studied at the Critical Care Medicine Department, Cairo University. The commonest risk factors were hypertension, and obesity each in 54.2%, followed by Diabetes Mellitus and family history of CAD each in 41.7%, smoking in 37.5%, and finally dyslipidemia in 33.3%. Both CCSAC and Minnesota questionnaire significantly improved after PCI. Mean LVEDV was 117±26.9 at baseline and 110.9±26.3 after 1 month, mean LVESV was 58.8±22 and 53.1±21.2 at follow up and mean LVEF was 50.9±8.1% and 53.1±7.5 after 1 month, all with significant p value. The Minnesota Score, LVEF, LVESV & MPI significantly improved in pts with impaired baseline LVEF than those with normal LVEF. 408 segments were analysed, 84 segments showed RWMA in the form hypokinesia in 18%, and akinesia in 3%. Analysis of the affected segments revealed hypokinesia in 86.9% and akinesia in 13.1%. At follow up 33 segments (39.3%) showed improvement in the RWMS. According to different risk factors, the presence of HTN, absence of DM, & the absence of dyslipidemia were in favor with more improvement in the LV volumes and EF. None of the other risk factors showed significant effect before & after PCI. According to the type of medications, the use of β-Blockers (βB) or angiotensin converting enzyme inhibitors (ACEIs) or the absence of Ca Channel Blockers (CCB) was in favor of significant improvement in the Minnesota score, LV volumes and function, and regional LV function. According to angiographic criteria; pts with type A lesion (38%) showed improvement in Minnesota score, EF, ESV, MPI, and RWMSI than type B (33%) or C (29%). All patients showed clinical improvement by CCSAC whatever the lesion type. Pts with single vessel disease (58%) showed significant improvement in Minnesota score, EF, EDV, ESV, and MPI than those with 2 or more vessel affection. Pts who underwent total revascularization (62.5%) showed significant improvement in Minnesota score, EF, EDV, ESV, and MPI than those with subtotal revascularization (37.5%). Patients using Bare Metal Stents (75%) showed significant improvement in Minnesota Score, EF, EDV, ESV, MPI, and RWMSI than those using Drug Eluting Stents (25%). Conclusion. Early clinical & echocardiographic improvements after elective PCI. Absence of DM or dyslipidemia or the use of βB or ACEIs was in favor of better PCI effect. Complex lesion and higher number of affected vessels showed less improvement after elective PCI.
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Introduction

Over the past 30 years, dramatic improvements have been achieved in the safety of percutaneous coronary intervention (PCI) procedures, despite the increasing complexity of clinical and anatomic conditions treated. The need for emergent bypass surgery has declined from 8% in 1990 to far less than 1% in the current era, and the rate of vascular complications has declined dramatically as techniques have improved and procedural experience has increased [(1)].

In patients with significant amounts of viable myocardium, LV function may improve markedly, and even normalize, following successful revascularization.[(2-4)] Given the remarkable current periprocedural safety profile of elective coronary

intervention, it is important to predict the rate of success and study the factors affecting elective PCI outcome.

Aim of the work:

To detect the early effects of elective PCI on different clinical and echocardiographic variables in the whole studied population and in different patient subgroups.

2. Patients & Methods:

The study included twenty-four patients with established coronary artery disease who are candidates for elective PCI of one or more of coronary vessels. The study was conducted in the Critical Care Medicine Department, Cairo University, from the period of September 2009 to May 2010.

Exclusion criteria:

We excluded from the study pts with acute MI and those with any contraindication for coronary angiography.

All patients were subjected to:

Complete history and full clinical examination including 12-lead electrocardiogram (ECG); clinical assessment; echocardiographic examination and elective PCI.

A- Echocardiographic examination

All patients underwent conventional transthoracic echocardiographic examination before and one month after PCI. Each patient was examined in the left lateral decubitus position according to the recommendations of the American Society of Echocardiography using an ATL HDI 5000 colored echocardiographic machine using a 3.5 MHz. transducer.

The following parameters were measured

1- Global systolic function

- **Ejection fraction (EF):**

Left ventricular end-diastolic and end-systolic volumes were measured and LVEF was calculated using Simpson's rule (normal range 55 % - 75 %) [5].

$$EF = \frac{LVEDV - LVESV}{LVEDV} \times 100$$

2- Regional left ventricular function:

- A wall motion score index (WMSI) is derived by dividing the sum of the wall motion scores by the number of visualized segments (17 segments) [5].

3- Myocardial performance index:

Calculated by the following equation:

$$MPI = \frac{IVRT + IVCT}{ET}$$ (Normal: 0.39), Figure (1). [5]

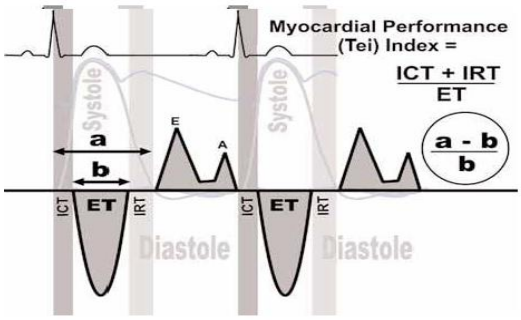

Figure (1) Calculation of MPI

B- Clinical assessment:

- Clinical assessment was done before and 1 month after PCI using:
  - Minnesota questionnaire (Table 1) and,
  - Canadian Cardiovascular Society Angina Classification.

Canadian Cardiovascular Society Angina Classification:

- Class 0: Asymptomatic.
- Class 1: Angina with strenuous exercise.
- Class 2: Angina with moderate exertion.
- Class 3: Angina with mild exertion :
  Walking 1-2 level blocks at normal pace
  Climbing 1 flight of stairs at normal pace
- Class 4: Angina at any level of physical exertion.

B- Revascularization technique (elective PCI):

- The procedures were performed using ***Integris H 300 (Philips NL company)*** catheterization laboratory. Pre-interventional medications included: Intravenous heparin (10000 to 15000 IU), to keep the activated clotting time > 300 sec during the procedure and oral Clopidogrel® 300 mg loading dose 24 hours before the procedure.
- Baseline diagnostic coronary angiography was first performed via femoral artery using Seldingers' technique with 6, 7, or 8 F left Judkins, Q or multipurpose guiding catheters for the detection of severity, and extent of coronary artery disease (CAD), lesion morphology was classified according to the ACC/AHA classification [6].

Table (1): Minnesota questionnaire

The following questions ask how much your heart failure (heart condition) affected your life during the past month (4 weeks). After each question, circle the 0, 1, 2, 3, 4 or 5 to show how much your life was affected. If a question does not apply to you, circle the 0 after that question.

Did your heart failure prevent you from living as you wanted during the past month (4 weeks) by -	No	Very Little				Very Much
1. causing swelling in your ankles or legs?	0	1	2	3	4	5
2. making you sit or lie down to rest during the day?	0	1	2	3	4	5
3. making your walking about or climbing stairs difficult?	0	1	2	3	4	5
4. making your working around the house or yard difficult?	0	1	2	3	4	5
5. making your going places away from home difficult?	0	1	2	3	4	5
6. making your sleeping well at night difficult?	0	1	2	3	4	5
7. making your relating to or doing things with your friends or family difficult?	0	1	2	3	4	5
8. making your working to earn a living difficult?	0	1	2	3	4	5
9. making your recreational pastimes, sports or hobbies difficult?	0	1	2	3	4	5
10. making your sexual activities difficult?	0	1	2	3	4	5
11. making you eat less of the foods you like?	0	1	2	3	4	5
12. making you short of breath?	0	1	2	3	4	5
13. making you tired, fatigued, or low on energy?	0	1	2	3	4	5
14. making you stay in a hospital?	0	1	2	3	4	5
15. costing you money for medical care?	0	1	2	3	4	5
16. giving you side effects from treatments?	0	1	2	3	4	5
17. making you feel you are a burden to your family or friends?	0	1	2	3	4	5
18. making you feel a loss of self-control in your life?	0	1	2	3	4	5
19. making you worry?	0	1	2	3	4	5
20. making it difficult for you to concentrate or remember things?	0	1	2	3	4	5
21. making you feel depressed?	0	1	2	3	4	5

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Follow up

Both clinical assessement and echocardiographic parameters were reevaluated 1 month post PCI

D- Statistical analysis:

Data were collected on special format, verified and then coded when needed prior to analysis. All continuous data were expressed as mean ± SD, categorical data were expressed as frequency in tables. Paired T test and non parametric t test (Mann Whitney test) were used for comparing means of values before and after revascularization. Tools to assess the accuracy of diagnostic test have been calculated. P value < 0.05 considered significant (CI is 95%). All analysis has been performed using SPSS 12 and graphics by MS excel.

3. Results

Our study was conducted on 24 patients who were admitted to the Critical Care Medicine Department, Cairo University, during the period from September 2009 till May 2010. All the studied populations were diagnosed to have CAD and underwent elective PCI to one or more coronary vessel.

Our results will be presented as follow:

A- Descriptive data: (Demographic, clinical, angiographic and echocardiographic data)

B- Comparative data: between baseline and one month post PCI; (For the whole population and in different pts subgroups)

A- Descriptive data

I. Demographic & clinical data

The mean age of the studied population was 55.7±9.3 years ranging from 40 to 71 years. Seventeen pts (70.2%) were males and 7 pts (29.8%) were females. Nine pts (37.5%) were smokers, Thirteen pts (54.2%) were hypertensive, 10 pts (41.7%) were diabetic, 8 pts (33.3%), were dyslipidemic, 10 pts (41.7%) had family history of CAD and 13 pts (54.2%) were obese (as measured by BMI).

II. Baseline angiographic data

1-Vessels affected:

Fifteen pts (62.5%) had LAD lesion, 11 pts (45.8%) had LCX lesion, 12 pts (50%) had RCA lesion

2-Number of vessels affected:

Ten pts (41.7%) had more than one vessel disease.

3-Type of lesion:

Nine Pts (38%) had type A lesion, while 8 pts (33%) had type B lesion and those with type C lesion were 7 pts (29%).

4- Type of revascularization:

Fifteen pts (62.5%) underwent total (complete) revascularization, while 9 pts (37.5%) had subtotal revascularization.

5-Number and type of stent:

A total number of 33 stents were deployed. Eighteen pts (75%) received 25 bare metal stent and six pts (25%) had 8 DES.

III. Baseline Echocardiographic data:

1-LV volumes and EF:

Mean LVEDV was 117±26.9, mean LVESV was 58.8±22 and mean LVEF was 50.9±8.1%. Ten pts (42%) had normal EF (≥50%) while 14 pts (58%) had reduced EF (< 50%)

408 segments were studied, 84 segments (21%) showed regional wall motion abnormalities in the form

hypokinesia in seventy three (18%), and akinesia in 11 pts (3%). Analysis of the affected segments revealed hypokinesia in 86.9% and akinesia in 13.1%. At follow up 33 segments (39.3%) showed improvement in the RWMS.

B) Comparison between before and one month post PCI data:

I) Whole population:

Clinical assessment

Both Canadian Cardiovascular Society Angina Classification and Minnesota questionnaire significantly improved after PCI (Table 2).

Table (2): Clinical and echocardiographic data before and after PCI:

	Before	After	P value
CCSAC	3.3±0.8	1.4±0.7	0.0001
MINNESOTA score	65.1±13.3	46.6±17.4	0.001
LVEDV (ml)	117±26.9	110.9±26.3	0.034
LVESV (ml)	58.8±22	53.1±21.2	0.014
EF (%)	50.9±8.1	53.1±7.5	0.004
MPI	0.66±0.12	0.6±0.097	0.008

Echocardiography

EDV and ESV showed a significant decline one month after revascularization. Patients showed a highly significant improvement in myocardial performance index one month after revascularization (Table 2) .

II) Patient Subgroups:

The effect of elective PCI on the measured variables was evaluation in different pts subgroups before and 1 month after PCI.

1) Diabetes Mellitus:

Both groups showed significant improvement in CCASC, Minnesota score and RWMAs index. The **non diabetic** group showed additional improvement in EF, EDV, ESV and MPI one month after PCI (Table 3)

Table (3): The effect of revascularization on diabetic pts

Diabetes	**Non diabetic (No=14)**			**Diabetic group (No=10)**		
	Before	**After**	**P val.**	**Before**	**After**	**P val.**
CCSAC	3.3±0.8	1.35±0.6	0.001	3.3±0.67	1.6±0.69	0.001
Minnesota	67.16±14.2	45.3±19.6	0.033	63.6±13.5	47.6±16.7	0.013
EF	53.3±7.5	56.2±6.4	0.003	47.6±8.1	48.9±7.2	NS
EDV	111±25.2	100.9±18.4	0.020	125.4±28.1	124.8±30.2	NS
ESV	53.1±19.9	44.5±13.4	0.010	66.9±23.2	65.3±24.6	NS
MPI	0.63±0.12	0.57±0.06	0.032	0.68±0.11	0.65±0.12	NS
RWMSI	1.19±0.12	1.12±0.07	0.001	1.29±0.1	1.23±0.1	0.025

2) Hypertension:

Both groups showed significant improvement in CCASC, ESV, MPI, and RWMSI. The **hypertensive** group showed additional significant improvement in Minnesota score, EF, and EDV. (Table 4).

Table (4): The effect of revascularization on hypertensive pts

Hypertension	**Non hypertensive (No= 11)**			**Hypertensive (No= 13)**		
	Before	**After**	**P- val.**	**Before**	**After**	**P- val.**
CCSAC	3±0.6	1.2±0.6	0.001	3.6±0.7	1.6±0.6	0.001
Minnesota	57.5±16.2	41.2±22	NS	70.8±7.3	46.8±14	0.002
EF	51.4±7	53.4±6.6	NS	50.5±9.2	52.9±8.5	0.039
EDV	107.3±23	105.4±27	NS	125±27.8	115.2±26	0.034
ESV	53.1±18.2	50.2±20	0.027	63.6±24.3	55.6±22.4	0.03
MPI	0.61±0.09	0.58±0.08	0.014	0.69±0.13	0.62±0.1	0.029
RWMSI	1.19±0.09	1.14±0.1	0.004	1.26±0.14	1.19±0.1	0.004

3) Obesity:

Both groups showed significant improvement in CCASC, Minnesota score, and RWMSI. The **non obese** group showed additional improvement in EF, and ESV (Table 5) .

Table (5): The effect of revascularization on obese pts

Obesity	Non Obese (No= 11)			Obese (No= 13)		
	Before	**After**	**p val.**	**Before**	**After**	**p val.**
CCSAC	3.5±0.7	1.3±0.5	0.001	3.1±0.8	1.5±0.8	0.001
Minnesota	58±12.3	37.8±15	0.011	69.8±12	53.2±16	0.032
EF	53.2±8.3	56±7.3	0.021	49±7.2	50.6±7.1	NS
EDV	111.6±22	101.9±10	NS	121.5±30.4	118.4±33	NS
ESV	53.2±19.	44.7±10.1	0.038	63.6±23.9	60.3±25.5	NS
MPI	0.63±0.11	0.56±0.06	NS	0.68±0.12	0.63±0.11	NS
RWMSI	1.18±0.09	1.11±0.06	0.001	1.27±0.13	1.21±0.1	0.014

4) Effect of revascularization on different baseline treatment groups:

i) Beta blockers

Eighteen patients (75%) were using beta blockers. Both groups showed significant improvement in CCSAC. The group **using βB** showed additional significant improvement in Minnesota score, EF, EDV, ESV, MPI, and RWMSI (Table 6) .

Table (6): The effect of revascularization on pts using beta blockers

B- blockers	No B-blockers (No= 6)			B-blockers (No= 18)		
	Before	**After**	**p val.**	**Before**	**After**	**p val.**
CCSAC	3.0±0.6	2.0±0.89	0.041	3.4±0.7	1.2±0.4	0.001
Minnesota	73±2.9	63±13.5	NS	62.2±14.3	42.1±15.9	0.001
EF	50.1±9.1	50.1±9.9	NS	51.2±8	54.1±6.6	0.002
EDV	118.6±37.6	119±44	NS	116±23.7	108±18.4	0.023
ESV	61.5±29.8	62.5±34.5	NS	58±19.7	50.0±14.6	0.006
MPI	0.69±0.14	0.67±0.14	NS	0.64±0.11	0.57±0.06	0.008
RWMSI	1.26±0.14	1.24±0.16	NS	1.22±0.11	1.14±0.08	0.001

ii) ACE Inhibitors

Fourteen patients (58%) were using ACE Inhibitors. Both groups showed significant improvement in CCSAC, while the group **using ACE Inhibitors** showed additional improvement in Minnesota score, EF, EDV, ESV, and RWMSI (Table 7).

Table (7): The effect of revascularization on pts using ACEI

ACEI	No ACEI (No= 10)			ACEI (No-= 14)		
	Before	**After**	**p val.**	**Before**	**After**	**p val.**
CCSAC	3.1±0.73	1.5±0.7	0.001	3.5±0.75	1.4±0.6	0.001
Minnesota	72.5±3.5	63.5±19	NS	63.5±14.12	43±16.2	0.01
EF	56.4±7.6	56.55±8.2	NS	47±6.1	50.7±6.3	0.001
EDV	103.8±19	103.9±19	NS	126.4±28.3	115.9±27.5	0.023
ESV	46±15.7	46.2±15.7	NS	68±21.6	58.2±21.3	0.007
MPI	0.58±0.09	0.57±0.08	NS	0.71±0.11	0.62±0.09	0.013
RWMSI	1.17±0.1	1.14±0.11	NS	1.27±0.12	1.18±0.24	0.0001

iii) Calcium channel blockers

Seven patients (29.1%) were using CCB. Both groups showed significant improvement in CCSAC. The group **not using CCB** showed additional significant improvement in Minnesota score, EF, EDV, ESV, MPI, and RWMSI (Table 8) .

Table (8): The effect of revascularization on pts using CCB

CCB	No CCB (No= 17)			CCB (No= 7)		
	Before	After	p val.	Before	After	p val.
CCSAC	3.4±0.7	1.2±0.4	0.0001	3±0.5	1.8±0.8	0.015
Minnesota	62.9±14.3	42.1±15.9	0.001	73.3±2.8	63±13.5	NS
EF	50.8±8.1	54.1±6.8	0.001	51.2±8.7	50.7±9.1	NS
EDV	117.2±24	108±18.8	0.026	116.2±34	116±40.8	NS
ESV	58.8±20	50.3±15	0.005	59±28	60±32.4	NS
MPI	0.65±0.11	0.58±0.05	0.013	0.67±0.13	0.65±0.15	NS
RWMSI	1.22±0.12	1.14±0.08	0.001	1.24±0.14	1.22±0.15	NS

5) Effect of revascularization on patients with different angiographic criteria.

A- Type of lesion

Patients were divided into three groups: patients with type A lesion (9 patients, 38%), type B lesion (8 patients, 33%) and type C lesion (7 patients, 29%). All groups showed significant improvement in CCSAC. In pts with **type A lesion,** there was additional improvement in Minnesota score, EF, ESV, MPI, and RWMSI. While in pts with **type B lesion**, there was significant improvement in Minnesota score, EF, FM%, and RWMSI (Table 9).

Table (9): The effect of revascularization on pts with different lesion types:

Lesion type	Lesion type A (No= 9)			Lesion type B (No-=8)			Lesion type C (No-=7)		
	Before	After	P-val	Before	After	P-val	Before	After	P-val
CCSAC	3.4±0.8	1.44±0.7	0.001	3.3±0.9	1.25±0.4	0.0001	3.1±0.3	1.7±0.77	0.003
Minnesota	69±14.7	43±18.7	0.028	56.2±14.3	35.2±5.1	0.021	71.5±2.3	65.5±9.3	NS
EF	50.8±8.6	54.6±7.9	0.001	53.1±8.1	56.2±4.9	0.047	48.5±8	47.7±7.6	NS
EDV	112.7±22.8	104.3±21	NS	112±23.9	104±9.2	NS	128.1±34.7	127±39.2	NS
ESV	56.3±19.2	47.3±15.5	0.025	53.7±19.4	45.8±8.7	NS	68±27.9	68.2±30.4	NS
MPI	0.66±0.13	0.58±0.06	0.042	0.63±0.11	0.57±0.04	NS	0.67±0.13	0.66±0.15	NS
RWMSI	1.21±0.14	1.13±0.09	0.004	1.22±0.1	1.13±0.06	0.009	1.27±0.11	1.24±0.14	NS

B- Number of affected vessels

Fourteen pts (58%) had single vessel disease, while 10 pts (42%) had multivessel affection. Both groups showed significant improvement in CCSAC, and RWMSI. The group with **single vessel disease** showed additional improvement in Minnesota score, EF, EDV, ESV, and MPI (Table 10) .

Table (10): The effect of revascularization in relation to the number of vessels affected:

No of vessels	*Single vessel disease (No= 14)*			*Multi vessel disease (No= 10)*		
	Before	*After*	*p val.*	*Before*	*After*	*P val.*
CCSAC	3.4±0.85	1.35±0.49	0.001	3.2±0.6	1.6±0.8	0.001
Minnesota	64.3±12.9	41.5±±15.6	0.002	66.6±15.5	55.8±18.13	NS
EF	49.7±8.8	52.6±8.08	0.009	52.6±7.1	53.9±7.2	NS
EDV	123.7±28	112.5±26.4	0.013	107.6±23.4	108.6±27.4	NS
ESV	63.7±23.7	54.2±21.8	0.009	52.1±18.3	51.6±21.3	NS
MPI	0.68±0.13	0.61±0.1	0.026	0.62±0.101	0.59±0.09	NS
RWMSI	1.24±0.13	1.16±0.12	0.001	1.22±0.11	1.16±0.1	0.034

C. Type of revasualrization

Fifteen patients (62%) underwent total revascularization and 9 patients (38%) underwent incomplete revascularization. Both groups showed significant improvement CCSAC, and RWMSI, while only the group that underwent **total revascularization** showed significant improvement in Minnesota score, EF, EDV, ESV, and MPI post PCI (Table 11) .

Table (11): The effect of total and subtotal revascularization

Revascul. type	*Total (No=15)*			*Subtotal (No= 9)*		
	Before	**After**	**P-val.**	**Before**	**After**	**P-val.**
CCSAC	3.3±0.8	1.2±0.41	0.001	3.3±0.5	1.8±0.7	0.001
Minnesota	60.4±14.6	38.6±12	0.002	73.6±4.1	61±16.9	NS
EF	50.8±8.9	54±7.9	0.002	51.1±7	51.7±7.1	NS
EDV	118.8±29	110.3±26.6	0.041	114±23	111.7±27.4	NS
ESV	60±24.5	52±21.8	0.014	56.8±18.8	55.1±21.2	NS
MPI	0.66±0.03	0.59±0.1	0.026	0.65±0.11	0.61±0.09	NS
RWMSI	1.22±0.13	1.15±0.12	0.0001	1.24±0.1	1.18±0.1	0.040

C- Type of the stent:

Eighteen patients (75%) implanted Bare Metal Stents (BMS) while 6 pts (25%) used Drug Eluting Stents (DES). Both groups showed significant improvement in CCSAC. Patients using **BMS** showed significant improvement in Minnesota Score, EF, EDV, ESV, MPI, and RWMSI. (Table 12)

6) Effect of revascularization on pts with normal and impaired baseline EF.

Ten pts (42%) had normal baseline LVEF (≥50%), while 14 pts (58%) had reduced EF. Both groups showed significant improvement in CCSAC, and RWMSI. The group with **impaired baseline EF** showed additional improvement in Minnesota score, EF, ESV, and MPI. (Table 13)

Table (12): The effect of revascularization on pts using BMS and DES.

Type of stent	*BMS (75%)*			*DES (25%)*		
	Before	***After***	***p val.***	***Before***	***After***	***p val.***
CCSAC	3.33±0.8	1.3±0.6	0.001	3.33±0.51	1.66±0.8	0.011
Minnesota	67.1±13.8	46.1±16.2	0.003	60.2±12.5	48±22.7	NS
EF	51.3±7.9	54.1±7.6	0.001	49.8±9.2	50.16±7.3	NS
EDV	112.7±25	106.5±25	0.018	129.6±29.5	124±28.4	NS
ESV	56.4±20.9	49.9±19.9	0.005	66.8±23.7	62.2±23.7	NS
MPI	0.65±0.12	0.59±0.1	0.024	0.67±0.107	0.62±0.09	NS
RWMSI	1.22±0.13	1.14±0.1	0.001	1.27±0.07	1.22±0.11	NS

Table (13): Effect of PCI on pts with normal and impaired baseline EF

Baseline EF	**Normal EF (No= 10)**			**Reduced baseline EF (No= 14)**		
	Before	**After**	**p val.**	**Before**	**After**	**p val.**
CCSAC	3.1±0.7	1.4±0.6	0.001	3.5±0.7	1.5±0.6	0.001
EF	59.5±3.7	60.1±4.2	NS	44.8±3.3	48.2±5.1	0.002
EDV	95.5±10.6	93.1±10.2	NS	132.2±24	123.5±27.2	NS
ESV	38.7±5.4	36.7±4.3	NS	73.2±17.3	64.9±20.5	0.030
MPI	0.55±0.04	0.53±0.04	NS	0.73±0.1	0.65±0.09	0.015
RWMSI	1.13±0.05	1.09±0.05	0.011	1.3±-0.1	1.22±0.11	0.001

4. Discussion:

There is a relation between myocardial blood flow and systolic function, the so-called "flow function" relation [(7)] . As blood flow is reduced, there is a corresponding reduction in contractile performance ("perfusion-contraction matching"). There may no ischemic symptoms or necrosis when this occurs slowly since blood flow and function are once again in equilibrium [(8)] .

In the past, severe left ventricular (LV) dysfunction was considered an irreversible condition, as regional akinesis was thought to represent infarcted myocardial tissue. It is now understood that, among patients with ischemic cardiomyopathy, LV systolic dysfunction can result from myocardial necrosis, myocardial hibernation, or repetitive myocardial stunning. While myocardial necrosis is irreversible, systolic dysfunction resulting from hibernation and stunning are potentially reversible states of ventricular dysfunction [(9)] .

Myocardial revascularization using PCI is widely used and improves clinical outcome particularly in post infarction patients with markedly reduced LVEF [(10)] .

Echocardiography has become an established and powerful tool for diagnosing the presence of coronary artery disease and defining its consequences in patients with acute ischemic syndromes and those with chronic coronary atherosclerosis. Transthoracic imaging and Doppler techniques are generally sufficient for

evaluating patients with suspected or documented ischemic heart disease. [11]

Echocardiographic studies may help in planning revascularization procedures by demonstrating the functional significance of a given coronary stenosis. Moreover, because restenosis is a common complication, reassessment roughly 1 month after angioplasty is a reasonable time frame within which to assess the functional results of angioplasty [12] .

In our study, we found that PCI is associated with a significant improvement in heart failure and angina symptoms as shown by improvement in Minnesota Score and Canadian Cardiovascular Society Angina Classification.

Our results agree with those of ***Zellweger et al.,*** [13] who documented the beneficial effect of PCI on symptoms and extent of ischemia and ***Buszman et al.,*** [10] who found a significant improvement in heart failure symptoms as shown by improvement in NYHA class. This also agrees with ***Momtahen et al.,*** who conducted his study on 110 patients and found that PCI was associated with a significant improvement in clinical outcome as shown by functional improvement in NYHA class and angina severity [14] .

Our results suggest that PCI is associated with a significant improvement in global functions as shown by the significant improvement in LVEF and MPI. This improvement of the global LV functions was significant one month post-PCI.

Our results agree with those of ***Dzavik and colleagues,*** who studied 244 patients and showed that the restoration of coronary patency of non-acute occluded coronary arteries is associated with a small but significant improvement in global LV function [15] . Also with results of ***Zellweger et al.,*** who found a significant decrease in ESV and EDV after PCI as compared to pre-PCI findings which points to a positive effect on left ventricular remodeling even in the absence of significant changes in EF [13] .

And again in concordance to ***Momtahen et al.,*** who conducted his study on 110 patients with CAD and assessed LV function by echocardiography before and after revascularization. He found that PCI was associated with a significant improvement in global LV function (as shown by improvement in LVEF) and this improvement of LV contractility was significant one month post-PCI. [14]

In our study, we found a significant improvement in regional LV function post revascularization as shown by the significant improvement in RWMSI.

Our result agrees with ***Dzavik and colleagues,*** who showed that the restoration of coronary patency of occluded coronary arteries is associated with a significant improvement in regional function [15] .

This was in concordance to ***Momtahen et al.,*** who stated that PCI was associated with a significant improvement in regional LV function as assessed by RWMSI [14] .

In our study patients with baseline impaired Ejection Fraction (<50%) showed significant improvement in global and regional LV functions and clinical assessment post revascularization.

This agrees with ***Dzavik et al,*** who stated that the improvement in LVEF after revascularization was more significant in patients with base line impaired EF. [15] It also matches the results of ***Buszman et al.,*** and ***Dudek et al.,*** who showed a significant improvement in LV function in patients with baseline depressed LV function after PCI [10,16] .

This again was in concordant to ***Momtahen et al.,*** who stated that The LVEF improvement was nonetheless more pronounced in patients with baseline impaired EF (LVEF ≤ 40%). Therefore, it appears that patients with more severe LV dysfunction will achieve more benefits from PCI [14] .

In our study 62% of patients underwent total (complete) revascularization. These patients showed significant improvement of global LV function represented by significant improvement in EF and MPI, while 38% of patients underwent subtotal (incomplete) revascularization and showed non-significant change in EF and MPI after revascularization.

This was in concordance to ***Kirschbaum et al.,*** who conducted his study at 2010 on 61 patients and assessed LVEF before and 6 months after revascularization. The EF improved significantly after complete revascularization (46% to 51%; $p< 0.0001$) but did not change after incomplete (49% to 49%; with $p=0.88$) or unsuccessful revascularization (49% to 47%; $p=0.11$). [17]

In our study, 14 patients (58.3%) were using ACE inhibitors. This group showed significant clinical improvement in heart failure and angina symptoms as well as global and regional LV functional improvement and a significant reduction in EDV and ESV 1month after revascularization while the group not using ACE inhibitors showed non significant change in heart failure symptoms nor global or regional LV function and didn't show significant reduction in EDV and ESV after revascularization.

This partially agrees with ***Kjøller-Hanse et al.,*** in the APRES study who conducted his study on 159 patients In this study, they found that in patients with asymptomatic and moderate left ventricular dysfunction undergoing invasive revascularization for chronic stable angina pectoris, long-term treatment with ramipril®, initiated shortly after invasive revascularization, reduced the incidence of cardiac death, AMI and development of clinical heart failure but regarding the recurrent angina pectoris, the study showed no significant benefit with ramipril® therapy [18, 19] .

In our study the group of patients (75%) using beta blockers showed a significant clinical improvement and a significant improvement in the global and the regional LV functions 1 month after revascularization while the group not using beta blockers showed only significant improvement in the angina symptoms and non significant change in heart failure symptoms nor global nor regional LV functions.

Our results matched that of the study conducted by ***Chan et al.,*** who showed that beta-blocker use was associated with a marked survival benefit among patients undergoing successful elective percutaneous coronary revascularization [(20)] .

In our study diabetic patients (41%) showed non-significant improvement in global LV systolic functions(LVEF and MPI)and in LV volumes, the non diabetic group showed a significant improvement in both global and regional LV functions ,both groups(diabetics and non diabetic patients) showed a significant improvement in clinical symptoms after revascularization.

Knuesel et al., and Schinkel et al., has designed a study to assess the prediction of improvement of LV function and heart failure symptoms after coronary revascularization in patients with diabetes mellitus and ischemic LV dysfunction, using 18F-FDG imaging. Twenty six percent were diabetics who showed less functional improvement as assessed by echocardiography and when assesses by 18F-FDG SPECT after oral administration of acipimox they concluded that is practical for routine assessment of myocardial viability in patients with ischemic LV dysfunction with or without diabetes mellitus [(, 20)] .

So that one of our limitations that diabetic patients specifically should be assesed by 18F-FDG SPECT rather than echocardiography after coronary revascularization.

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