*Al-Azhar Med. J . (cardiology).* *Vol. 52 (2), April, 2023, 729-738*
*DOI:* 10.21608/amj.2023.291695
*https://amj.journals.ekb.eg/article_291695.html*

# ROLE OF PERCUTANEOUS CORONARY INTERVENTION IN IMPROVEMENT OF ISCHEMIC MITRAL REGURGITATION

By

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## ABSTRACT

**Background:** The management of ischemic mitral regurgitation (MR) represents a therapeutic challenge and is still controversial. The restoration of coronary blood flow reduces left ventricular remodeling and improves regional and global left ventricular function. The effect of revascularization by percutaneous coronary intervention (PCI) for coronary artery disease (CAD) on the severity of ischemic MR is still unclear. This strategy is expected to attenuate ischemic MR.

**Objective:** To evaluate the role of PCI in the improvement of Ischemic MR in patients with CAD.

**Patients and methods:** Fifty patients undergoing PCI were enrolled in the study with assessment of severity of MR by transthoracic echocardiography before and 4 weeks after PCI. This study was carried out at Cardiology Department, Sohag Cardiac Specialised center, from March 2018 to December 2019.

**Results:** There was significant improvement of severity of ischemic MR in patients with CAD after PCI.

**Conclusion:** PCI was useful in treatment of patients with ischemic MR due to its beneficial role in the improvement of the degree of ischemic MR as well as left ventricular (LV) systolic function.

**Key words:** Percutaneous coronary intervention, ischemic mitral regurgitation, coronary artery disease.

## INTRODUCTION

Ischaemic heart disease (IHD) is a major contributor to the global disease burden, with devastating consequences in terms of human life and health *(Virani et al., 2020)*.

Mitral valve disease is a frequent cause of heart failure and death. Emerging evidence indicates that the mitral valve is not a passive structure, but even in adult life remains dynamic and accessible for treatment. This concept motivates efforts to reduce the clinical progression of mitral valve disease through early detection and modification of underlying mechanisms *(Levine et al., 2015)*.

Ischemic mitral regurgitation is a mitral insufficiency caused by myocardial ischemia or infarction. The term ischemic mitral regurgitation excludes rheumatic, degenerative, myxomatous, connective tissue disease, spontaneous ruptured chordae tendineae, and other causes of acute or chronic mitral regurgitation due to infection, inflammation, trauma, congenital abnormalities (including mitral

valve prolapse), annular calcification, or tumors *(Gillinov et al., 2011)*.

Pathophysiologic mechanisms leading to ischemic mitral regurgitation included a change of left ventricular geometry and shape with a normal mitral valve apparatus. On this basis, the restoration of coronary blood flow reduces left ventricular remodeling and improves left ventricular function. This strategy should attenuate ischemic MR *(Kang et al., 2011)*.

**The aim of this study was to** evaluate the role of percutaneous coronary intervention (PCI) in the improvement of Ischemic MR in patients with coronary artery disease (CAD).

## PATIENTS AND METHODS

This study included 50 patients diagnosed as ischemic heart disease (including chronic coronary syndrome and acute coronary syndrome) with MR. All of them were candidates for coronary angiography and percutaneous coronary intervention either as elective or emergent procedure. This study was carried out at Cardiology Department, Sohag Cardiac Specialised center, from March 2018 to December 2019.

**Inclusion criteria:**

- Gender: Both male and female patients were included.
- Inpatients admitted by ACS (UA-NSTEMI- STEMI).
- Outpatients with chronic stable angina.

**Exclusion criteria:**

- Patients with valvular heart diseases.
- Patients with non ischemic causes of MR.
- Patients with congenital heart disease.
- Patients with previous myocardial revascularization (CABG or PCI)
- Patients with failed PCI.

**Ethical Aspects:**

Consent was obtained from every patient after explanation of the procedure. Medical research and ethics committee approved the study.

**Data collection:** The data collection included:

1. Full history was taken from all patients including name, age, sex, occupation, family history and risk factors for CAD including smoking, hypertension, diabetes mellitus, dyslipidemia and sedentary lifestyle.
2. Full clinical examination with special emphasis on pulse, blood pressure, and local cardiac examination.
3. Laboratory investigations including random blood glucose (RBG) level, Serum creatinine level, lipid profile (Total cholesterol (TC), LDL, HDL, triglyceride (TG)), International normalized ratio (INR), complete blood count (CBC) and serology (HBsAg, HCVAb, HIV).
4. Electrocardiogram (ECG): Resting 12-leads ECG was done by ECG MAC device, EM-301 model. Evaluation of all electrocardiographs was done to diagnose each type of coronary artery disease.
5. Echocardiography (ECHO) was done using Vivid GE, Dimensions echocardiogram using 3-5 MHz

transducer for assessment of chambers' dimensions, left ventricular systolic and diastolic function, presence and degree of MR and left ventricular wall motion abnormality. Assessment of was done before and 4 weeks after PCI. Assessment of severity of MR was done According to the guidelines of the American College of Cardiology/ American Heart Association (ACC/AHA) for grading MR (Nishimura et al., 2014): (1) Jet area to the left atrial area ratio: (Mild MR) Grade 1+: ratio < 20%, (Moderate MR) Grade 2+: ratio 20-39%, (Severe MR) Grade 3+: ratio ≥ 40%. (2) Vena Contracta (VC) width: Mild MR: VC < 3mm, Moderate MR: VC 3 – 6.9mm, Severe MR: VC ≥ 7mm.

6. Coronary angiography (CA) and percutaneous coronary intervention (PCI) were done by using Siemens Artis zee 20×20 for assessment of the severity and distribution of coronary affection, and patients were subjected to revascularization by PCI using standard technique to the lesions with ≥ 70% stenosis.

**Statistical analysis:**

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 20.0. Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

Paired t test (t), McNemar test (X2McNemar), Wilcoxon signed ranked test (z) and Monte Carlo test (MCP), p-value <0.05 was considered significant.

## RESULTS

In our study, the mean age of the patients was 56.76 ± 9.42, 39 patients (78%) were males and 11 (22%) were females, 22 patients (40%) were hypertensive, 22 patients (40%) were diabetic, 31 (62%) were current smokers. 24 (48%) patients were dyslipidemic, 11 patients (22%) have positive family history of ischemic heart disease and 10 patients (20%) have obesity **(Table 1)**.

**Table (1): Demographic data and clinical risk factors of the study population**

| Sociodemographic characteristics and clinical data | Study sample (No=50) | |
|---|---|---|
| | No | % |
| **Gender** | | |
| **Male** | 39 | 78 |
| **Female** | 11 | 22 |
| **Age (Years)** | | |
| **Mean± SD** | 56.76 ± 9.42 | |
| | **Positive** | **Negative** |
| | **No** | **%** |
| **Smoking** | 31 | 62 |
| **HTN** | 22 | 44 |
| **DM** | 22 | 44 |
| **Dyslipedemia** | 24 | 48 |
| **Family history of IHD** | 11 | 22 |
| **Obesity** | 10 | 20 |

According to clinical data, there was a significant improvement in dyspnea (90% before PCI Vs 38% after PCI), (P=0.005), and also there was significant improvement in Chest Pain (66% before PCI Vs 12% after PCI), (P=0.022) **(Table 2)**.

**Table (2): Assessment of MR patients before and after PCI as regards (Dyspnoea & Chest Pain)**

| | Before PCI (No=50) | | After PCI (No=50) | | (P) |
|---|---|---|---|---|---|
| | No | % | No | % | |
| **Dyspnea** | | | | | |
| Yes | 45 | 90 | 19 | 38 | **(P=0.005)** |
| No | 5 | 10 | 31 | 62 | |
| **Chest Pain** | | | | | |
| Yes | 33 | 66 | 6 | 12 | **(P=0.022)** |
| No | 17 | 34 | 44 | 88 | |

According to echocardiographic data, mean left ventricular end diastolic diameter (LVEDD) was 55.6 ± 4.6 and 54.7 ± 4.39 before and after PCI respectively, (p= 0.006), mean left ventricular end systolic diameter (LVESD) was 37 ± 5.6 and 36 ± 5.3 before and after PCI respectively, (p= 0.002), mean ejection fraction (EF) by M-mode method was 46.9 ± 7.89 and 48.2 ± 8.61 before and after PCI respectively, (p= 0.0001), mean ejection fraction (EF) by Simpson's method was 46.3 ± 7.43 and 47.7 ± 8.25 before and after PCI respectively, (p=0.00008), mean MR jet area was 6.98 ± 2.07 and 4.80 ± 2.72 before and after PCI respectively, (p <0.00001), mean MR jet area/ left atrium (LA) area was 38.34 ± 10.80 and 25.88 ± 14.03 before and after PCI respectively, (p < 0.00001), mean vena contracta (VC) width was 5.55 ± 1.64 and 3.79 ± 2.13 before and after PCI respectively, (p < .00001), mean LA diameter was 3.9 ± 0.52 and 3.84 ± 0.48 before and after PCI respectively, (p= 0.028), mean LA area was 18.14 ± 2.10 and 18.10 ± 2.10 before and after PCI respectively, (p= 0.728 ) and mean systolic wall motion (SWM) score index was 1.42 ± 0.34 and 1.28 ± 0.32 before and after PCI respectively, (p= 0.0001).

LV systolic function as assessed by LVEF significantly improved following PCI (p = 0.0001) **(Table 3)**.

**Table (3): Echocardiographic Assessment (Before Vs After PCI)**

| PCI / Echo Assessment | Before PCI (No=50) Mean ±SD | After PCI (No=50) Mean ±SD | (P) |
|---|---|---|---|
| **LVEDD** | 55.6 ± 4.6 | 54.7 ± 4.39 | p= 0.006 |
| **LVESD** | 37 ± 5.6 | 36 ± 5.3 | p= 0.002 |
| **EF % (M-mode)** | 46.9 ± 7.89 | 48.2 ± 8.61 | p= 0.0001 |
| **EF % (Simpson's)** | 46.3 ± 7.43 | 47.7 ± 8.25 | p=0.00008 |
| **MR jet area** | 6.98 ± 2.07 | 4.80 ± 2.72 | p <0.00001 |
| **MR jet area/LA area** | 38.34 ± 10.80 | 25.88 ± 14.03 | p < 0.00001 |
| **VC width** | 5.55 ± 1.64 | 3.79 ± 2.13 | p < .00001 |
| **LA diameter** | 3.9 ± 0.52 | 3.84 ± 0.48 | p= 0.028 |
| **LA area** | 18.14 ± 2.10 | 18.10 ± 2.10 | p= 0.728 |
| **SWM Score** | 1.42 ± 0.34 | 1.28 ± 0.32 | p= 0.0001 |

32 patients (64%) have grade II MR and 18 patients (36%) have III MR.

34 patients representing 68% have an improvement in ischemic MR grade following PCI while 16 patients representing 32% have no improvement of ischemic MR grade following PCI, (p= .0001) **(Table 4)**.

**Table (4): Assessment of Severity of MR Assessment (Before Vs after PCI)**

| Severity of ischemic MR after PCI (No=50) / Severity of ischemic MR Before PCI | NO MR | | Grade I | | Grade II | | Grade III | | (P) |
|---|---|---|---|---|---|---|---|---|---|
| | No | % | No | % | No | % | No | % | |
| Grade II | 5 | 10 | 15 | 30 | 10 | 20 | 2 | 4 | p= 0.0001 |
| Grade III | 0 | 0 | 9 | 18 | 5 | 10 | 4 | 8 | |

According to CA and PCI data, distribution of patients as regards CAD was 20 patients (40%) have LAD disease, 9 patients (18%) have RCA disease, 6 patients (12%) have LCX disease and the remaining 15 patients (30%) have 2 vessel disease **(Table 5)**.

**Table (5): Distribution of patients as regards CAD**

| CAD | Frequency (NO=50) | |
|---|---|---|
| | NO | % |
| LAD | 20 | 40 |
| LCX | 6 | 12 |
| RCA | 9 | 18 |
| LAD & LCX | 3 | 6 |
| LAD & RCA | 3 | 6 |
| RCA & LCX | 9 | 18 |

Regarding the culprit artery and grade of MR, in LAD 18 patients (72%) have grade II MR while 7 patients (28%) have grade III MR, in RCA 9 patients (56.3%) have grade II MR while 7 patients (43.7%) have grade III MR and in LCX 5 patients (55.6%) have grade II MR while 4 patients (44.4%) have grade III MR **(Table 6)**.

**Table (6): Coronary artery diseased vessels (culprit vessel) distribution among patients with grade II, III ischemic MR.**

| CAD (No=50) / MR | LAD (N=25) | | LCX (N=9) | | RCA (N=16) | | (P) |
|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No | % | |
| Grade II | 18 | 72 | 5 | 55.6 | 9 | 56.3 | P=0.499 |
| Grade III | 7 | 28 | 4 | 44.4 | 7 | 43.7 | |

Regarding comparison of SWM score index according to culprit artery before and after PCI there is significant improvement after PCI as; in LAD lesion mean of SWM score index before PCI and after PCI was 1.38 ± 0.27 and 1.22 ± 0.18 respectively (p= .0001), in LCX lesion mean of SWM score index before PCI and after PCI was 1.65 ± 0.5 and 1.5 ± 0.55 respectively (p= .002) and in RCA lesion as mean of SWM score index before PCI and after PCI was 1.36 ± 0.27 and 1.23 ± 0.26 respectively (p= .004) **(Table 7)**.

**Table (7): Comparison of SWM score index according to culprit artery before and after PCI**

| PCI / SWM score index | Before PCI Mean ±SD | After PCI Mean ±SD | (P) |
|---|---|---|---|
| **LAD** | 1.38 ± 0.27 | 1.22 ± 0.18 | p= 0.0001 |
| **LCX** | 1.65 ± 0.5 | 1.5 ± 0.55 | p < 0.05 |
| **RCA** | 1.36 ± 0.27 | 1.23 ± 0.26 | p= 0.004 |

## DISCUSSION

Ischemic MR is a frequent complication of left ventricular (LV) global or regional pathological remodeling due to chronic coronary artery disease. It is not a valve disease but represents the valvular consequences of increased tethering forces and reduced closing forces. IMR is defined as mitral regurgitation caused by chronic changes of LV structure and function due to ischemic heart disease and it worsens the prognosis *(Varma et al., 2017)*.

The terms secondary, functional, and ischemic MR are often used interchangeably as a means to differentiate from primary or degenerative MR, which is defined as regurgitation caused by pathology of the mitral valve (MV) leaflets and/or supporting chordae *(Kron et al., 2017)*.

In our study, we aimed to evaluate the role of PCI in improvement of Ischemic MR in patients with CAD by assessment of the severity of MR by transthoracic echocardiography before and 4 weeks after PCI, and we found that there was highly significant improvement of severity Ischemic MR in patients with CAD after PCI (p= .0001), also we found that LV systolic function as assessed by LVEF significantly improved following PCI.

Our study speculated that successful reperfusion prevents the development of MR by limiting the infarct size, attenuating and preventing infarct expansion and dyskinesia especially in area of myocardium supporting the papillary muscles.

*Chua et al. (2010)* concluded that the PCI is more effective in decreasing the incidence of moderate or severe Ischemic MR after myocardial infarction, compared to results for patients with no PCI.

*Walid et al. (2012)* found that patients with successful reperfusion with PCI showed significant reductions in the severity of Ischemic MR.

*Uddin et al. (2012)* found that MR was a major long-term mortality predictor. In addition, it has been shown to be associated with lower EF, poor functional status, and a higher incidence of clinical

shock, which could explain increased mortality with severe Ischemic MR.

In disagreement with our study, *Gaber et al. (2014)* found that there were no significant difference regarding LVEF, LVEDD, LVESD and SWM score either pre or post PCI.

*David and Judy, (2014)* documented that follow up LVEF and SWMI were significant predictors of Ischemic MR improvement following PCI. This may support that Ischemic MR improvement is secondary to the improvement of regional and global LV function and attenuation of the LV remodeling, as long as vessel patency is maintained.

Similar to our study, *El-Akabawy et al. (2018)* demonstrated that patients showed significant improvement of the LVEF and SWM Index after PCI.

## LIMITATIONS

The major limitation of our study was that it was done in absence of randomized controlled comparison. With the data available for this analysis, we were unable to characterize the predominant mechanism of Ischemic MR in patients included in our cohort. Studies utilizing novel imaging technologies, such as 3-dimensional echocardiography, aimed to more precisely characterize the mechanism, and, therefore, the most appropriate therapy of Ischemic MR. The limited number of cases included in our study added to the overall limitation of the study. However, each patient underwent two examinations giving a total number of 100 echo Doppler examination, but still if a large number of patients was included (probably from many centers), the result obtained would be more valuable.

## CONCLUSION

PCI was useful in treatment of patients with ischemic MR due to its beneficial role in the improvement of the degree of ischemic MR as well as LV systolic function.

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# دور القسطرة التداخلية في تحسين إرتجاع الصمام الميترالي الناتج من داء الشريان التاجي

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**خلفية البحث:** يعتبر إرتجاع الصمام الميترالي من المضاعفات الأساسية لإحتشاء عضلة القلب و قصور الشرايين التاجية للقلب الناتج عن تغيرات بعضلة البطين الأيسر للقلب. مازال معالجة ارتجاع الصمام الميترالي الناتج من قصور الشريان التاجي يعتبر تحدياً. استعادة تدفق الدم في الشريان التاجي عن طريق القسطرة التداخلية يحسن من وظيفة البطين الأيسر ومن المتوقع أن تحسن هذه الخطة من إرتجاع الصمام الميترالي.

**الهدف من البحث:** تقييم دور القسطرة التداخلية في تحسين إرتجاع الصمام الميترالي الناتج عن داء الشريان التاجي.

**المرضى وطرق البحث:** أجريت هذه الدراسة بقسم القلب بمركز القلب والجهاز الهضمي بسوهاج على خمسين مريض من مرضى قصور الشرايين التاجية المصحوب بإرتجاع الصمام الميترالي وجميعهم خضعوا للقسطرة التداخلية. وتم تقييم درجة ارتجاع الصمام الميترالي بالموجات الصوتية على القلب قبل القسطرة التداخلية ثم بعدها بأربعة أسابيع وامتد البحث من مارس 2018 حتى ديسمبر 2019.

**نتائج البحث:** تحسن درجة إرتجاع الصمام الميترالي بعد أربعة أسابيع من القسطرة التداخلية في أكثر من ثلثي المرضى المشمولين بالبحث.

**الاستنتاج:** القسطرة التداخلية ذات جدوى في تحسين إرتجاع الصمام الميترالي الناتج عن داء الشريان التاجي.

**الكلمات الدالة:** إرتجاع الصمام الميترالي، قصور الشرايين التاجية، القسطرة التداخلية.