Evaluation the Rate of Reverse Remodeling After Elective PCI in Patients with Ventricular Dysfunction

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Abstract:

Introduction: Therapies that showed the pathology of left ventricular remodeling are often associated with improved outcomes. The incidence and impact of reverse left ventricular (LV) remodeling after percutaneous coronary intervention (PCI) is still unknown. Reverse remodeling is associated with improved long-term prognosis in patients with acute myocardial infarction. However, its determinants are still not fully understood. On the other hand, due to the increasing use of PCI in the treatment of coronary artery disease, its complications are significant, so this study was conducted with the aim of investigating the rate of reverse remodeling after elective PCI in patients with ventricular dysfunction.

Method and material: This study was a cohort study. The invited cases were examined by trained people after providing explanations and completing the informed consent form. According to the vascular involvement in angiography, PCI patients were performed by a specialist on the involved vessel. For candidate patients, PCI was performed on the day of admission in the hospital, and echocardiography was performed. These patients had received the same drug intervention, including aspirin and Plavix, beta-blocker and ACE-inhibitor. The patients were hospitalized for one day and after the visit due to the absence of angiography complications such as re-bleeding at the angiography site and hematoma and bruising at the site, they were discharged with medication instructions. Also, 6 months after PCI, the patients underwent the evaluation of the above indicators by echocardiography again. The demographic characteristics of the patients were investigated. Also, hemoglobin, cardiac output and mitral valve insufficiency were evaluated before and after PCI.

Results: The present study was conducted on 100 referring patients who were candidates for PCI. Our results showed that 62 of the patients were men and 38 were women. The average age was 62.79 for men and 62.71 for women. Patients had underlying disease of diabetes, kidney problem (ESRD), ischemic heart disease (IHN) and high blood pressure (HTN). The highest rate of vascular involvement among patients was related to the RCA vein. With the increase in the number of underlying diseases, the number of involved vessels also increased, heart rate and diastolic failure showed improvement 6 months after the intervention, and the MR rate decreased significantly after the intervention. The findings show that PCI has been able to increase the percentage of cardiac efficiency. It should be noted that this increase of 6.5% (EF>5%) is completely significant (P<0.0001). In our study, the number of people with normal left ventricular size increased after the intervention.

Conclusion: PCI with hemodynamic support may be a potential therapeutic strategy to select patients with underlying cardiac and renal disease and reduced EF. Also, PCI is effective in improving mitral valve failure, diastolic failure and improving heart rate and reverse remodeling of the left ventricle.
Keyword:
Reverse left ventricular (LV) remodeling (rLVR), percutaneous coronary intervention (PCI), coronary, Ejection Fraction (EF), Mitral regurgitation (MR)

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Introduction:

Coronary artery disease Is the most common cause of death caused by diseases, and about 50% of men and 30% of women after the age of 40 have symptomatic coronary artery disease (1).Coronary angiography is the standard diagnostic method for coronary artery disease, and based on its findings, the appropriate treatment is selected for the disease, which includes: medical treatment, percutaneous coronary intervention (PCI) and coronary artery bypass surgery.(2).PCI is one of the increasing methods in the treatment of coronary artery disease, and with the increase in the experience of doctors and the improvement of auxiliary medical treatments and the advancement of technology, the number of PCI has increased by 226% in America from 1987 to 2001. The side effects of PCI are noteworthy and important. Among its major complications are vascular complications, which are about 0.4%, and infection is one of these complications. Although bacteremia is uncommon after PCI, it is associated with significant complications and in fatal cases (3).Today, this method has changed the face of providing cardiac care as a low-risk, economical and less invasive method compared to surgery (4, 5); So that only in the United States, more than 650 thousand people undergo angioplasty and stenting procedures every year (6-8).Even in Iran, although exact statistics are not available, with the increasing prevalence of coronary artery disease, a large number of patients need surgical interventions (angioplasty and coronary artery bypass surgery) every day (9, 10).Despite rapid advances in percutaneous coronary interventions (PCI), a certain proportion of patients with acute coronary syndrome (ACS) clinically exhibit left ventricular (LV) dysfunction in the area supplied by the damaged coronary artery. According to previous studies, about 20-30% of patients with ST-segment elevation myocardial infarction (STEMI) treated with primary PCI suffer from significant myocardial damage, which leads to unfavorable remodeling. In turn, This is consistent with an increased risk of major cardiovascular adverse events (11, 12).The final outcome of myocardial infarction is inextricably linked with the occurrence of long-term complications such as heart failure and malignant ventricular arrhythmias, or indeed, poor quality of life and increased mortality. This particularly refers to anterior wall STEMI, which is caused by acute arterial occlusion. The left anterior descending artery (LAD) develops, causing a large state of necrosis and remodeling of the left ventricle and further systolic and diastolic dysfunction (13, 14).Left ventricular wall reperfusion significantly increases the risk of major cardiovascular adverse events (MACE), mortality rate. Pharmacological management of STEMI in the form of angiotensin-converting enzyme inhibitors (ACEI), beta blockers and receptor antagonists. Mineralocorticoids (MRA) lead to a reduction in the development of pathological LV remodeling. Recently, the concept of reverse remodeling has been developed, which is defined as a decrease in LV end-systolic volume (LVESV) of ≥ 10% relative to the baseline value (15, 16).Notably, reversible inverse reconstruction was associated with favorable response to cardiac resynchronization therapy (CRT) and improved prognosis in patients with heart failure (17).Most importantly, reversible reperfusion was associated with improved long-term prognosis in patients with acute myocardial infarction. However, its determinants are still not fully understood (18).As more patients survive and live longer after stroke, the prevalence of cardiac injury after myocardial infarction continues to increase. The development of cardiac injury phenotype in these patients is a complex, progressive, molecular and cellular transformation to derives the name "ventricular remodeling". First described by Tennant and Wiggers, ventricular remodeling involves ventricular dilatation, scar formation, and geometric changes in left ventricular (LV) shape (eg, oval to more spherical) and partially by Neurohormones are directed (19).The main evidence-based therapies of cardiac injury, in an effort to prevent adverse remodeling and promote reversible remodeling, ultimately target these neurohormonal pathways to ultimately improve outcomes in the post-myocardial infarction population.The Incidence and impact of reversible left ventricular remodeling after percutaneous coronary intervention (PCI) is unknown (20).In the study of Perera and colleagues in 2022, they showed that among patients with severe left ventricular ischemic systolic dysfunction who received optimal medical treatment, revascularization after PCI did not lead to a reduction in the mortality of patients hospitalized due to heart failure(48).In a study by Daubert and colleagues in 2015, it was shown that left ventricular reverse remodeling can occur after PCI at risk in patients with complex coronary artery disease and reduced EF and is associated with improved clinical outcomes (46).In the study of Peng and his colleagues in 2017, they showed that the development of reversible inverse reconstruction in patients with revascularization is favorable and appropriate. More studies are necessary to evaluate its prognostic role in predicting side effects (50).Until now, studies on stenting in chronic coronary heart failure patients have not shown a clear effect. Therefore, this study was conducted with the aim of investigating the rate of reversible left ventricular dysfunction following elective PCI in patients with ventricular dysfunction.

Materials and methods:
This study was a cohort study.Patients with ventricular dysfunction EF < 50% were candidates for PCI.The data collection tool related to patients' information was done using a checklist.After providing explanations and completing the informed consent form, all the invited people were examined by trained people based on a written program. This examination included blood pressure measurements, tonometric indices (waist circumference, hip circumference, height and weight according to the relevant standards). And the electrocardiogram (cardiogram of 12 leads) was performed by a trained expert with the interpretation of cardiologists.In this study, patients were subjected to angiography according to the changes in ECG and cardiac symptoms, including chest pain and shortness of breath.According to the vascular involvement in angiography, PCI patients were performed by a specialist in inversion on the involved vessel. For candidate patients for PCI, echocardiography was performed on the day of admission to the hospital.The patients were hospitalized for one day and after the visit due to the absence of angiography complications such as rebleeding at the angiography site and hematoma and bruising at the site, they were discharged with medication orders.Also, 6 months after PCI, the patients underwent the evaluation of the above indicators by performing echocardiography again, and at the same time, through an interview, the level of physical performance capacity of the patients was determined based on the New York Heart Association (NYHA) criteria. The rate of reverse remodeling of patients is also based on the reduction of left ventricular end systolic volume (LVESV) greater than or equal to 10%, as well as the reduction of left ventricular end diastolic volume greater than or equal to 20% and the increase of left ventricular ejection fraction (EF) and improvement of the severity of mitral regurgitation in the 6-month observation. In this study, a 3D echocardiography device was used.A decrease in hemoglobin level less than 12 grams per liter in women and less than 13 grams per liter in men was considered as anemia based on the definition of the World Health Organization.To check the state of dehydration, the density of the urine of the patients was measured by a refractometer device. According to the studies conducted in this case, the hydration status of the people according to the specific gravity of the urine was divided into four groups: normal hydration status (specific gravity <1.009), mild dehydration (1.019-1.010), moderate dehydration (1-020/1/029), severe dehydration (specific gravity>1.029) was divided.The echocardiographic criterion of E/E′ ratio is obtained using transmitral pulsed wave Doppler and tissue Doppler imaging of mitral valve movements. In this ratio, E is actually the peak intensity of the initial diastolic filling of the left ventricle and E′ is the average peak of the initial diastolic intensity. A valve obtained from the septal and lateral parts of the mitral valve is tissue Doppler.It was expected that In patients who have decreased left ventricular function due to vascular occlusion, after performing PCI and establishing sufficient flow, left ventricular function will improve with echocardiographic criteria and patient symptoms.MR severity, E/é' ratio, IVC size, ejection

fraction improvement and GLS were also determined by echocardiography.Known coronary heart disease patients with various degrees of diastolic dysfunction and with left ventricular ejection fraction (LVEF) less than 50% during echocardiography before PCI.Patients who had STEMI and reduced EF were included in the study if 40 days had passed since diagnosis.SPSS version 24 software was used to enter and analyze the data. For quantitative data, the Kolmogorov-Smirnov test was first performed, and if normal, paired t-tests were used to compare the mean of quantitative variables before and after PCI, and otherwise, the Wilcoxon test was used. To compare the qualitative data, Chi-square test or Fisher's exact test was used if needed. A significance level of less than or equal to 0.05 ($P<0.05$) is considered.

Findings:
The present study was conducted on 100 patients referred to. In this study, 62 patients are men and 38 are women. The average age was 62.79 for men and 62.71 for women.Examination of BMI in these patients revealed that the average of this index was 24.04 in men and 22.33 in women, and statistical analysis shows the significance of this difference between men and women in this study ($P<0.05$).Examining the results of the underlying diseases among the patients showed that 22 of the patients were smokers and 43 of the patients had diabetes. 2 of the patients had kidney problems (ESRD), 11 had ischemic heart disease (IHD) and 36 had They had high blood pressure (HTN).Examining the patients' blood tests showed that the distribution of hemoglobin levels before and after the intervention was not normal. The Wilcoxon test showed that there was no significant difference between the hemoglobin levels before and after the intervention.The examination of the heart rate (HR) showed that the distribution of HR before and after the intervention was not normal. The Wilcoxon statistical test showed that there was a significant difference between the HR before and after the intervention ($P<0.0001$).The results of mitral valve regurgitation (MR) using the chi-squared test showed that the amount of MR decreased significantly before and after the intervention ($P<0.003$).The results of diastolic dysfunction (E/E') showed that the comparison of the two groups in the Wilcoxon statistical test was completely significant ($P<0.008$). It should be noted that our data in this variable is not complete and echo was not performed in all patients.The results of examining the size of IVC in the Wilcoxon test showed that this variable had no significant difference before and after the intervention and was normal and below 2 in the patients.The results of cardiac efficiency (EF) investigations in patients before and after the intervention using the Wilcoxon test showed that the cardiac efficiency before the intervention was lower than its value after the intervention. This finding shows that PCI has been able to increase the percentage of cardiac efficiency. It should be noted that this increase of 5.6% (EF>5%) was completely significant ($P<0.0001$). The observations of the present study showed that with the increase in the number of underlying diseases, the amount of cardiac output decreased, which with the intervention PCI has improved this much.The results of examining the left ventricular size (LV size) in patients before and after the intervention with the Chi-squared test showed that the ventricular size improved after the intervention ($P<0.001$). This finding shows the importance of PCI in left ventricular reverse reconstruction in patients.The results of performing PCI on different vessels showed that LAD (32 people), RCA (44 people), LCX (18 people), OM

(19 people) and D (7 people) were involved. These results show that RCA is the severity of involvement. It has more than other vessels.The results of comparing the difference of cardiac output (EF) in patients before and after with the type of vessel involved using one-way ANOVA test showed that there is no significant relationship between the type of vessel and the improvement of EF among patients.Comparison of left ventricular size (LV size) after the intervention among different PCI vessels with one-way ANOVA test shows that the type of vessel has no significant relationship with the size of the left ventricle after the intervention.The results of investigating the number of involved vessels (VD) in different patients showed that 40 people had only one involved vessel (SVD), 45 people had two involved vessels (2VD) and 14 people had 3 involved vessels (3VD). In fact, almost half of the patients had two involved vessels. The number of underlying diseases had a positive relationship with the number of involved vessels, and with the increase in the number of underlying diseases, the number of involved vessels also increased.

Discussion:

The present study was conducted on 100 referring patients who were candidates for PCI. In this study, 62 of the patients were men and 38 were women. The average age for men was 62.79 and for women was 62.71. The underlying diseases were diabetes, kidney disease (ESRD), ischemic heart disease (IHD), and high blood pressure (HTN). Most of them were related to diabetes, IHD, and ESRD. In our study, an increase in the number of underlying diseases was associated with a decrease in cardiac output. This case was improved by stenting. The patients' hemoglobin did not change significantly during the intervention.On the other hand, the highest rate of vascular involvement among patients was related to the RCA vein. Half of the patients had two vessels involved in the disease. Our research showed that the underlying disease has a positive relationship with the number of involved vessels, and with the increase in the number of underlying diseases, the number The involved vessels also increase.Heart rate and diastolic failure improved 6 months after the intervention, and the MR rate decreased significantly after the intervention, all of which indicate the effect of PCI in improving mitral valve failure, diastolic failure, and reducing heart rate.Echocardiographic imaging in patients with coronary artery disease (CAD) has shown that a decrease in ejection fraction (EF) over time is an independent predictor of death and in-hospital heart failure (42, 51-53).The patients of this study had a low baseline EF, and PCI increased cardiac efficiency by 6.5% after 6 months of intervention. In this regard, it has been reported that in high-risk patients with severe obstructive CAD, percutaneous coronary intervention (PCI) with hemodynamic support may be considered as an alternative treatment strategy. Several studies on patients with symptomatic heart failure and reduced systolic function have shown that increased EF as a result of drug or device intervention is associated with improved outcomes. It can be used as a surrogate marker for future clinical events (54-56).The increasing number of coronary artery disease (CAD) patients with reduced left ventricular (LV) systolic function is a major clinical problem (57).Considering that LV systolic function is a powerful prognostic predictor in patients with CAD, whether treatment by improving LV systolic function benefits patients or not is an important clinical question that should be considered in time. While coronary artery bypass graft surgery (CABG) is considered the preferred treatment for CAD patients with reduced systolic function, percutaneous coronary intervention (PCI) has also become a strategy of choice in CAD patients. With reduced systolic function (58).Although PCI can improve LV function in some cases, it is not always effective, and the types or conditions of patients who benefit from improved LV function from revascularization by PCI remain unknown. LV functional improvement is usually accompanied by a decrease in LV end-systolic volume. Is related, which is defined as Reveres LV remodeling (LVRR) (56, 59).Pathological left ventricular (LV) remodeling, characterized by increased LV volume and decreased systolic function, can occur in response to ischemia and myocardial infarction (MI) and is associated with poor clinical outcomes (51, 60). Several studies show that the extent of LV volume increase reflects the magnitude of primary microvascular damage (61-63).In our study, the number of people with normal size of the left ventricle increased after the intervention, so it can be concluded that PCI was effective in the reverse reconstruction of the left ventricle. Another study in this regard reported that the reverse reconstruction of the left ventricle can be PCI occurs in patients with complex coronary artery disease and reduced EF and is associated with improved clinical outcomes (46). Interestingly, little is known about LV remodeling after PCI in patients with LV dysfunction.The PROTECT II trial demonstrated that percutaneous revascularization with hemodynamic support is a viable alternative treatment strategy in symptomatic but inoperable patients with complicated CAD and reduced EF. Reverse remodeling occurred in patients with symptomatic heart failure, lower baseline EF, and more extensive revascularization (46).Studies on patients with severe CAD and LV defects treated with CABG have shown that postoperative LV reverse remodeling occurs with a mean increase in EF from 4% to 14.1% (64, 65).Recently, in the STICH trial, it was shown that patients with the lowest preoperative EF (25%) and the largest ESV index (N90 ml/m2) were more likely to have a greater improvement in postoperative EF than CABG (66). In addition, patients with symptomatic heart failure were more likely to show reverse LV remodeling and subsequently had a significant improvement in NYHA functional class compared to baseline.The results of the Revived study in 2022 indicate that revascularization after PCI did not lead to a reduction in the mortality of patients hospitalized due to heart failure, but it was able to improve the quality of life in 6 and 12 months after PCI compared to the optimal treatment group. It should be noted that this difference in recovery was reduced at 24 months (48).Overall, larger prospective studies with longer durations are needed to evaluate the long-term sustainability and benefit of reverse LV remodeling after high-risk PCI.

Conclusion:

PCI can have a significant effect on LV reverse remodeling, which in turn is associated with a significant reduction in adverse clinical events. This study suggests that PCI with hemodynamic support may be a potential therapeutic strategy to select patients with underlying heart disease and Kidney and EF are reduced. Also, PCI is effective in improving mitral valve failure, diastolic failure and improving heart rate and reverse left ventricular reconstruction.

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