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# The Relationship between Coronary Artery Movement Type and Stenosis Severity with Acute Myocardial Infarction

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ABSTRACT

**Introduction**: The severity of coronary artery stenosis which leads to myocardial infarction (MI) has been a matter of controversy. Historical data are in favor of mild luminal stenosis (<50% diameter stenosis) while recent studies suggest hemodynamically-significant coronary stenosis as the main substrate for subsequent MI. Also, mechanical stress resulted from coronary artery movement (CAM) may be responsible for plaques rupture. In this study, we evaluated the severity of plaques leading to MI and common CAM patterns in the involved coronary segments.
**Methods**: In a cross-sectional descriptive-analytical study, on patients with acute ST-segment myocardial infarction (STEMI) undergoing coronary angiography, the relationship between coronary artery movement type and stenosis severity with acute MI was evaluated. Lesions with stenosis diameter greater than 50 percent were defined as moderate and those equal or higher than 70% were defined as severe stenosis. Three different patterns of coronary artery motion including compression, bending and displacement types were evaluated in segments with culprit lesion.
**Results**: One hundred and sixty two patients were enrolled. Ninety patients (55.6%) were male and 72 (44.4%) were female. Mean age of the patients was 60.56±13.43 years. In terms of Infarct related lesions (IRLs), 86% of the cases had at least moderate stenosis and in 67%, severe stenosis was present. More than 50% stenosis was found in all patients with anterior STEMI involving LAD. Among three types of coronary motion patterns, compression pattern was significantly higher in LAD ($P$<0.001), RCA ($P$<0.001), Diagonal artery ($P$<0.001) and OM branch ($P$=0.044), but not in proper LCX ($P$=0.307).
**Conclusion**: Most of the lesions leading to myocardial infarction have a diameter stenosis of at least 50% and mainly are located in the coronary segments with compression movement pattern.

## Introduction

ST-segment myocardial infarction (STEMI) generally takes place due to the rupture or erosion of a vulnerable plaque. The severity of coronary stenosis which leads to myocardial infarction (MI) has been a matter of controversy. Historical data report majority of MIs occur at locations of mild luminal stenosis (50% diameter stenosis).[1-3] This idea has been challenged by findings of recent studies which suggest hemodynamically-significant coronary stenosis is more likely to cause a subsequent MI.[4-7]
Besides the severity of the underlying plaques, the studies have also suggested the relationship between mechanical stress (e.g. the movement of vessels) and the site of atherosclerosis and plaque rupture.[8-10]
Mechanical stress in coronary arteries may cause atherosclerotic lesions and endothelial damages. Coronary artery movement (CAM) patterns have been classified, and it has been suggested that compression CAM is associated with higher degrees of stenosis.[10]
The aim of this study was to evaluate the relationship between coronary artery movement type during the cardiac cycle and stenosis severity with acute myocardial infarction.

## Materials and methods

In a cross-sectional descriptive-analytical study on

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patients with acute STEMI diagnosis undergoing coronary angiography at the same hospitalization, the relationship between coronary artery movement type and stenosis severity with acute MI was evaluated. STEMI was defined as chest pain with ST-segment elevation of ≥1 mm in 2 contiguous limb leads or ≥2 mm in 2 contiguous chest leads. The study was conducted in Shahid Madani Heart Center, affiliated to Tabriz University of Medical Sciences, Tabriz, Iran. The study was approved by the ethics committee of the university. Written informed consent was obtained from patients prior to the enrollment. One hundred and sixty two consecutive patients who were admitted with the diagnosis of acute STEMI during 1st February 2010 to 1st February 2011 who underwent coronary artery angiography at the same hospitalization were enrolled in the study. Exclusion criteria included history of coronary artery bypass grafting, left main (LM) target lesion, or MI due to in-stent stenosis or in-stent thrombosis.

Infarct related lesions (IRLs) were identified considering the location of ischemic changes in electrocardiogram, presence of wall motion abnormality in echocardiography and angiographic appearance of lesions. All lesions were assessed in two orthogonal views in order to avoid foreshortening and vessel overlap. Analysis of the angiograms was performed by two experienced interventionists. Moderate lesions were defined as stenosis greater than 50% and severe lesions were defined as stenosis equal or greater than 70%.

CAM pattern was categorized to three major groups based on Konta's study.[8] Based on this description, three patterns of compression (segmental length is shortened without vertical deviation of the artery), bending (coronary artery flexes into a single large curve) and displacement (location of the coronary artery shifts without change of segmental length or shape) were defined for the segment's movement pattern. Then, the IRL was compared with other segments in terms of severity of stenosis and movement pattern.

### *Method of Data Analysis*

Data obtained from the study were evaluated by descriptive statistical methods (frequency, percentage, mean ± SD), chi squared test or Fisher's exact test using SPSS v.15 statistical software. In this study, $P<0.05$ was considered statistically significant.

## Results

One hundred and sixty two patients were enrolled. Ninety patients (55.6%) were male and 72 (44.4%) were female. Mean age of the patients was 60.56 ± 13.43 years. Diabetes was present in 46 (28.4%) patients, hypertension in 63 (38.9%) and 61 (37.7%) patients were current smokers. The IRLS was left anterior descending artery (LAD) in 97 cases, right coronary artery (RCA) in 43 cases, left circumflex artery (LCX) in 11 cases, obtuse marginal artery (OM) in 8 cases and diagonal in 3 cases. In terms of IRLS, 86% of the cases had at least moderate stenosis (i.e. stenosis greater than 50%) and in 67%, severe stenosis (i.e. stenosis equal or more than 70%) was present (Figure 1). In our study, Compression pattern was observed in the target vessel in 134 patients (81.5%), Bend pattern in 20 (12.3%) and Displacement pattern in 8 (6.2%). The frequency of compression movement pattern was 84.5% when LAD had the IRL. The percentage of compression movement pattern when LCX, RCA, OM and diagonal vessels had IRL were 54.5%, 86%, 75%, and 100%, respectively. (Table 1).

Ninety seven patients had anterior STEMI and in all of them LAD had the IRL. In 100% of these cases at least moderate stenosis and in 78% severe stenosis was present in IRL. Among these cases 82 (84.5%) had compression, 10 (10.3%) had bend and 5 (5.2%) had displacement movement pattern.

Fifty four patients had inferior STEMI among which RCA had IRL in 43 cases and LCX had IRL in 11 cases. In cases with inferior STEMI in which RCA had the IRL, the lesions had at least moderate stenosis in 27 (63%) of cases and severe stenosis in 21 (49%) of cases. In cases with inferior STEMI on LCX, 10 (91%) had at least moderate stenosis and 6 (55%) had severe stenosis.

With regard to CAM, among inferior STEMIs in which RCA had the IRL, 37 patients (86%) had compression movement pattern and 6 (14%) had bend movement pattern. None of the cases had displacement movement pattern. Among cases with inferior STEMI on LCX, 6 (54.5%) had compression, 3 (27%) had bend and 2(18%) had displacement movement pattern.

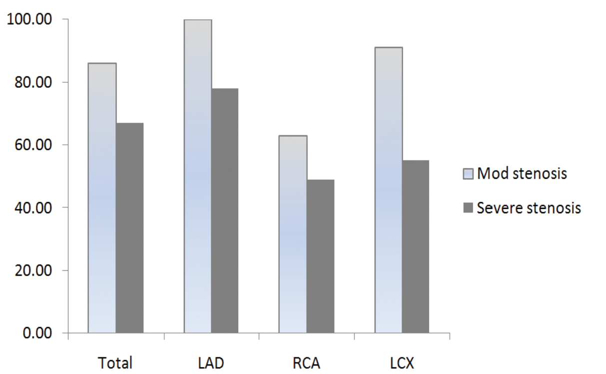


**Figure 1**. Frequency of Stenosis severity of IRLs. Moderate Stenosis; between 50 and 70%; Severe stenosis ≥ 70%.

## Discussion

In a review of angiograms available one week before AMI, Ojio *et al*. reported that the mean severity of stenosis in infarct-related lesions before AMI was 71±12%.6 Frobert *et al*. in a prospective study on 250 patients with STEMI stated that underlying stenosis of IRLs in their study was over 50% in 99% and over 70% in 66% of the patients.[7]

In our study 86% of patients had a culprit lesion with at least moderate stenosis and 67% had severe stenosis, both

**Table 1**. Coronary artery movement pattern in different vessels with culprit lesion

| | | Infract related artery motion pattern | | | *P* |
|---|---|---|---|---|---|
| | | Compression | Bend | Displacement | |
| Involved articles | LAD | 82 | 10 | 5 | <0.001 |
| | LCX | 6 | 3 | 2 | 0. 307 |
| | RCA | 37 | 6 | - | <0.001 |
| | OM | 6 | 1 | 1 | 0.044 |
| | Diagonal | 3 | - | - | <0.001 |

indicating that the severity of diameter stenosis leading to myocardial infarction is not as low as previously thought. Also lesions with stenosis diameter of less than 50% are more common than those with stenosis diameter higher than 50%, proving the higher rate of infarction in high grade lesions.

Few studies have evaluated the movement pattern of coronary arteries and its relationship with severity of atherosclerosis. In the study of Konta *et al*, CAM was categorized into 10 patterns and 3 main groups, including Bend type (where coronary arteries are bent in curve shape), Compression type (linear shortening without vertical deviations) and displacement type (that the location of the coronary arteries is displaced without any change in the length or segment form).[8]

In our study, we simply categorized CAM in three above mentioned types and noticed that among 162 lesions (suspected to be culprit lesion), Compression pattern was present in 134 (82.7%), Bend pattern in 20 (12.3%) and Displacement pattern in 8 plaques (4.9%).

In a study by Konta *et al*. evaluating the movement patterns of coronary arteries with incidence of atherosclerosis, it was suggested that the severity atherosclerosis in Compression movement pattern was significantly higher than in Bend and Displacement patterns.[8]

In our study as well, the frequency of Compression pattern was higher in target vessel in the patients under study; as in 84.5% of the patients with MI in LAD, the motion pattern was of the Compression type; and the frequency of Compression pattern in the patients with MI in LCX, RCA, OM, and Diagonal vessels was 54.5%, 86%, 75%, and 100%, respectively.

Konta *et al*. in a study in 2003 stated that the frequency of Compression pattern was higher in the proximal and middle of LAD, Diagonal, OM and in the middle of LCX.[8] In our study, similar to the results of the above study, frequency of Compression pattern was higher in the proximal and middle of LAD, Diagonal, OM but not in the LCX. We believe that unique course of LCX in atrioventricular groove prevents its compression by the adjacent structures and this might justify why in our study compression type lesion was not significantly high in LCX.

Similarly, O`Longhlin *et al*. and Chan *et al*. also showed that there is a significant relationship between Compression pattern and STEMI.[9,10] Also, Ambrose *et al*. stated that in MI patients, incidence and severity of stenosis in the vessel involved was over 70%.[11]

In our study, in 100% of MI patients with LAD involvement, there was at least moderate stenosis (i.e. stenosis greater than 50%) in this vessel; as well, stenosis of over 50% was observed in 90% of the coronary arteries involved in MI patients with LCX involvement. Also, a more than moderate stenosis was observed in MI target vessels of RCA and OM in 62% and 75% of the patients respectively; which similar to the results of the above study it indicates a highly significant relationship between the severity of stenosis of coronary arteries and the IM-involved vessel. Yoshino et al. suggested that in most patients, infarct-related lesion was more severe in the MI-involved vessel.[12] Lanzarini *et al*., in a study evaluating AMI patients during PCI, stated that only in 34% of patients, AMI-vessel was normal and had no significant stenosis.[13] In our study, in most of the MI patients under study, severity of stenosis was higher in the vessel causing MI.

According to this study, it can be concluded that most of the lesions leading to myocardial infarction have a diameter stenosis of at least 50%, and are mainly located in the spots with compression movement pattern. The present study cannot rule out the role of inflammation caused by plaque rupture in severity of stenosis; therefore, conduction of a study using IVUS system is recommended.

**Ethical issues**: The study was approved by the ethics committee of the University. Written informed consent was obtained from patients prior to the enrollment.

**Competing interests**: The authors had no competing interests to declare in relation to this article.

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