UDC 616.127-005.8-06:616.126.422
DOI https://doi.org/10.32782/2226-2008-2025-1-9

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ANALYSIS OF THE OCCURRENCE AND COURSE OF SECONDARY ISCHEMIC MITRAL REGURGITATION IN PATIENTS WITH ACUTE MYOCARDIAL INFARCTION

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Introduction. One of the complications due to myocardial infarction is secondary mitral regurgitation, which occur from left atrial or left ventricular (LV) dysfunction or after the rupture of the mitral subvalvular apparatus. Ischemic secondary mitral regurgitation occurs in 7–32% of cases according to various literature sources. Due to its high frequency, it requires more detailed study.

The aim – to study the frequency of secondary ischemic mitral regurgitation in patients with acute myocardial infarction based on angiography data and the time before revascularization.

Materials and methods. The study included 149 patients with acute myocardial infarction. The following methods were used: general clinical examination, laboratory diagnostics, echocardiography, electrocardiography, and coronary angiography.

Results. Among patients with mitral regurgitation, infarct-dependent involvement of the right coronary artery was predominant – 46 (45.54%) patients, p = 0.016, followed by the circumflex branch of the left coronary artery – 34 (33.66%) patients, p = 0.015. A higher percentage of multivessel disease was observed in patients with mitral regurgitation – 57 (56.44%), p = 0.031. Moreover, higher-grade ischemic mitral regurgitation was more frequently observed in patients who underwent revascularization > 12 hours after the onset of symptoms.

Conclusions. Secondary ischemic mitral regurgitation in acute myocardial infarction was more commonly diagnosed in patients with infarct caused by right coronary artery lesions, followed by the circumflex branch of the left coronary artery. According to the obtained data, a longer duration from the onset of myocardial infarction symptoms tends to increase the degree of mitral regurgitation.

Keywords: acute myocardial infarction, mitral regurgitation, valve pathology, reperfusion, coronary disease.

УДК 616.127-005.8-06:616.126.422

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АНАЛІЗ ВИНИКНЕННЯ ТА ПЕРЕБІГУ ВТОРИННОЇ ІШЕМІЧНОЇ МІТРАЛЬНОЇ РЕГУРГІТАЦІЇ У ПАЦІЄНТІВ ІЗ ГОСТРИМ ІНФАРКТОМ МІОКАРДА

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Метою дослідження було вивчення частоти виникнення вторинної ішемічної мітральної регургітації у пацієнтів з гострим інфарктом міокарда відповідно до даних ангіографії та часу до реваскуляризації.

У пацієнтів з мітральною регургітацією переважало інфаркт-залежне ураження правої коронарної артерії (ПКА) та огинаючої гілки лівої коронарної артерії (ОГ ЛКА). Виявлено вищий відсоток багатосудинного ураження у пацієнтів з мітральною регургітацією. Ішемічна мітральна регургітація більшого ступеня частіше спостерігалася у пацієнтів, у яких реваскуляризація відбулася більше ніж через 12 годин після початку симптомів.

Висновки. Інфаркт-залежне ураження ПКА та ОГ ЛКА частіше зумовлює виникнення вторинної ішемічної мітральної регургітації у хворих із гострим інфарктом. Більш тривалий час з моменту початку симптомів інфаркту міокарда має тенденцію впливати на збільшення ступеня ішемічної мітральної регургітації.

Ключові слова: гострий інфаркт міокарда, ішемічна мітральна регургітація, клапанна патологія, реперфузія, ішемічна хвороба серця.

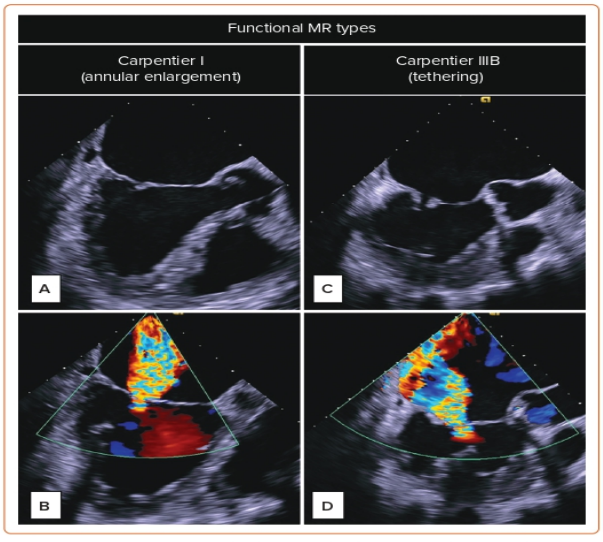
Introduction. Coronary heart disease (CHD) ranks among the most critical medical and social issues according to morbidity and mortality indicators. In European countries, the incidence of ST-segment elevation myocardial infarction associated with CHD is between 66 and 77 cases per 100.000 population annually [1]. Alarmingly, statistics on CHD-related mortality rates in Ukraine show that working-age adults are significantly affected, with 788 cases per 100.000 population annually of CHD patients and those with its complications losing their lives during their productive years [2]. Additionally, one in five patients diagnosed with CHD dies within the first year following diagnosis.

Acute myocardial infarction (AMI) is the most dangerous manifestation of CHD, which can lead to various com-

plications that significantly impact patient outcomes. The following are the most common complications associated with AMI: heart failure, cardiogenic shock, arrhythmias, myocardial rupture, pericarditis, thromboembolism, ventricular septal rupture, papillary muscle rupture, left ventricular aneurysm, valvular insufficiency and others.

One of the complications due to the myocardial infarction is ischemic mitral regurgitation (IMR). There are two echocardiographic types of IMR – primary and secondary. Primary IMR occurs after the rupture of the mitral subvalvular apparatus in the context of an AMI [3; 4]. Secondary IMR occurs from left atrial or left ventricular (LV) dysfunction. Regional or global LV dysfunction and adverse LV remodeling due to AMI lead to impaired leaflet motion and failure of leaflet overlap. Ischemic mitral regurgitation is a frequent complication of coronary artery disease and seen in approximately one-fifth of patients after an AMI [5]. Additionally, annular enlargement secondary to left atrial or ventricular dilatation and remodeling leads to impaired closing of the mitral leaflets and, in turn, regurgitation [6].

The Carpentier classification stratifies IMR based on leaflet motion. Type I is defined by normal leaflet motion (annular dilation, leaflet perforation), while type II is excessive leaflet motion (papillary muscle rupture, chordal rupture, redundant chordae), and type III is characterized by restricted leaflet motion. There are 2 subtypes of Type III – IIIa which is characterized by aberrant systolic excursion and diastolic coaptation, and subtype IIIb which is characterized by leaflet restriction limited to diastole. This article focuses on type III-restricted leaflet motion, and more specifically, type IIIb, which is restricted motion during systole in patients with ischemic or dilated cardiomyopathy. The disease processes seen with this type are LV dilatation, chordae tethering, and papillary muscle displacement (Figure 1) [7].



A and B: Carpentier 1 functional mitral regurgitation. C and D: Carpentier IIIB functional mitral regurgitation. B and C: The color Doppler demonstrates the direction of flow and regurgitation. MR = mitral regurgitation.

Fig. 1. Types of functional ischemic mitral regurgitation [7]

The aim of the study is to investigate the frequency of occurrence of secondary IMR in patients with acute myocardial infarction in relation to angiography data and time to revascularization.

Materials and methods. A total of 149 patients diagnosed with acute myocardial infarction with reduced left ventricular ejection fraction were included in the study, in accordance with the research objectives and aims. The patients were hospitalized in the Acute Coronary Syndrome and Myocardial Infarction Treatment Department of the State Institution "Heart Institute of the Ministry of Health of Ukraine" from March 2021 to November 2022. Among all patients, 113 (75.8%) were men and 36 (24.2%) were women, with an age ranging from 40 to 86 years, and the average age of the patients was (61 ± 8.54) years.

All patients were divided into two groups: those with acute myocardial infarction without IMR (n=48) and those with acute myocardial infarction accompanied by IMR (n=101).

Patients underwent a comprehensive set of clinical, laboratory, and instrumental methods of investigation to address the objectives outlined in the study.

The following research methods were utilized: general clinical examination of patients, laboratory diagnostic, echocardiography, electrocardiography and coronary angiography.

Interventional revascularization was performed as a procedure to restore coronary circulation via a distal access approach (femoral or radial) under fluoroscopic angiographic guidance. In our study, 338 stents were installed in patients, including 289 drug-eluting stents and 49 bare metal stents. Echocardiography was performed before revascularization and the next day after revascularization.

The present study was conducted in accordance with the basic principles of the European Convention of Human Rights and Biomedicine, World Medical Association Declaration of Helsinki on the ethical principles for medical research involving human subjects and current Ukrainian regulations. The study protocol was approved by the local ethics committee (№ 2/1 21.10.2024). The written informed consent was obtained from all the patients.

The obtained data were processed using standard statistical methods using a personal computer with Microsoft Word 2019, graphics were constructed using Microsoft Excel. Statistical processing was carried out using IBM SPSS Statistics 21. For statistical processing, qualitative and quantitative variables were determined. For qualitative data, a frequency analysis of the occurrence of features was performed, for quantitative data, the arithmetic mean (M) and standard (root mean square) error of the mean (m) were used as a measure of accuracy for the estimated population mean. Quantitative variables were tested for normality of distribution using descriptive statistics of the Kolmogorov-Smirnov criteria.

The results. According to the data from coronary angiography, electrocardiography, and echocardiography, the infarct-related artery was identified in the patients (Figure 2).

Comparing the data between the two study groups, we observe differences in the results of coronary angiography (Table 1). Notably, in patients with IMR, the right coronary artery was significantly more often responsible for the infarction – 46 (45.54%) patients, whereas in patients without IMR, the infarct-related artery was only present in 12 (25.00%) patients, with a p-value of 0.016. There was also a significantly

higher percentage of circumflex branch involvement of the left coronary artery in patients with impaired mitral valve function – 34 patients (33.66%), compared to 7 patients (14.58%) in the first group (p = 0.015). In contrast, the first group of patients, who did not exhibit pathological IMR, predominantly showed involvement of the left anterior descending artery – 29 patients, accounting for 60.42% of the entire group, whereas in patients with IMR, the infarct-related left anterior descending artery was present in 19 (18.81%) patients, with p < 0.0001. Only 2 patients (1.98%) from the second group had the left main coronary artery as the infarct-related artery, while none of the patients in the first group exhibited lesions in the left main coronary artery, p = 0.330.

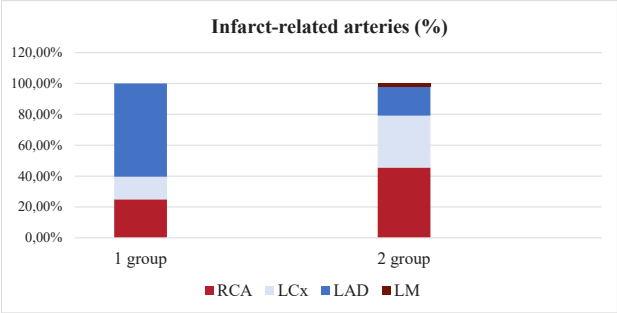


Fig. 2. Distribution of patients by infarct-related artery

Note. RCA – right coronary artery; LCx – circumflex branch of left coronary artery; LAD – left anterior descending artery; LM – left main artery.

Thus, we observe that IMR in the context of acute myocardial infarction with reduced left ventricular ejection fraction was more frequently recorded in cases when infarction was caused by lesions in the right coronary artery, followed by involvement of the circumflex branch of the left coronary artery.

Analyzing the results of coronary angiography, multivessel coronary artery disease was noted in 75 (50.34%) patients among all patients in both groups (Figure 3). Multivessel disease is defined as hemodynamically significant stenosis (70% or more) in three or more coronary arteries.

When comparing the data between the two groups, a significantly higher rate was found in patients with IMR – 57 (56.44%) – while multivessel disease was present in 18 (37.50%) patients among those without IMR, with p = 0.031.

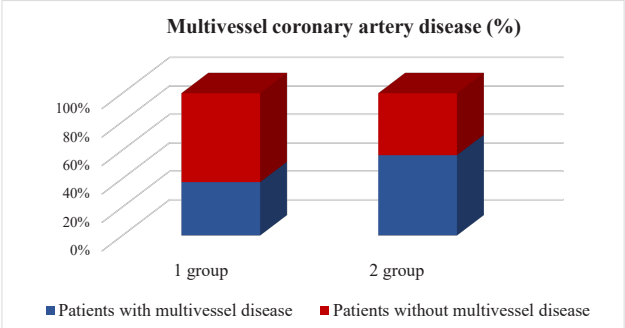


Fig. 3. Distribution of patients by the presence of multivessel coronary artery disease

A comparison was conducted between the mitral valve function of the two groups and the time elapsed from the onset of myocardial infarction symptoms to the moment of blood flow restoration in the infarct-related artery (Table 2).

In patients of the first group without impaired mitral valve function, 24 (50%) patients had a time to reperfusion of < 12 hours from the symptom onset, while for the remaining 24 (50%) patients, this time exceeded 12 hours.

Analyzing data from the second group, where patients exhibited IMR, we found that Grade I IMR was diagnosed

Table 1

Distribution of patients by infarct-related artery

Indicator		1 group n=48	2 group n=101	p
1		2	3	4
Infarct-related artery	LAD	29 (60.42 %)	19 (18.81 %)	*< 0.0001*
	RCA	12 (25.00 %)	46 (45.54 %)	0.016
	LCx	7 (14.58 %)	34 (33.66 %)	0.015
	LM	0	2 (1.98 %)	0.330
Multivessel coronary artery disease		18 (37,50 %)	57 (56.44 %)	0.031

Note. RCA – right coronary artery; LCx – circumflex branch of left coronary artery; LAD – left anterior descending artery; LM – left main artery.

Table 2

Distribution of patients by the time to reperfusion

Indicator		1 group n=48		2 group n=101		p	
		Time to reperfusion (hours)					
		Before 12 hours	After 12 hours	Before 12 hours	After 12 hours	Before 12 hours	After 12 hours
Grades of ischemic mitral regurgita-tion	0	24 (50.00%)	24 (50.00%)	0	0	*< 0.0001*	*< 0.0001*
	1	0	0	35 (34.66%)	33 (32.67%)	*< 0.0001*	*< 0.0001*
	2	0	0	10 (9.90%)	16 (15.84%)	0.024	0.004
	3	0	0	2 (1.98%)	5 (4.95%)	0.328	0.118

in 68 patients, of whom 35 (34.66%) patients underwent revascularization within 12 hours, while 33 (32.67%) patients had revascularization after 12 hours. The study results indicate that Grade II IMR was more frequently present in patients whose revascularization occurred > 12 hours after symptom onset – 16 patients (15.84%) – compared to those with a time to reperfusion of < 12 hours and Grade II IMR – 10 (9.90%) patients. Grade III IMR prevailed among patients in the second group with a time to reperfusion of > 12 hours – 5 (4.95%) patients, while severe IMR was diagnosed in 2 patients (1.98%) who underwent revascularization of the infarct-related artery within 12 hours from the onset of myocardial infarction (Figure 4).

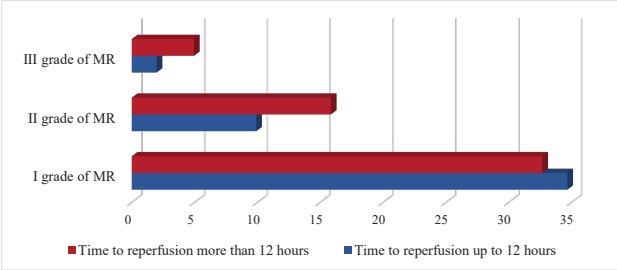


Fig. 4. Distribution of patients by the time to reperfusion

Thus, according to the obtained data, a longer time from the onset of myocardial infarction symptoms tends to influence an increase in the degree of IMR.

Discussion. A comprehensive examination enabled the identification of infarct-related arteries in patients with acute myocardial infarction and reduced left ventricular ejection fraction. The results indicated that, in patients with IMR, the right coronary artery was the cause of infarction – 46 (45.54%) patients compared to only 12 (25.00%) patients without IMR (p = 0.016). The circumflex branch of the left coronary artery was the second most common affected infarct-related artery in patients with IMR – 34 patients (33.66%), compared to 7 patients (14.58%) in the first group (p = 0.015). Conversely, in the first group of patients without pathological IMR, the left anterior descending artery was predominantly affected – 29 (60.42%) patients, while only 19 (18.81%) patients with IMR had the left anterior descending artery as the infarct-related vessel (p < 0.0001). An infarct-related stenosis in the left main coronary artery was documented in 2 (1.98%) patients from the second group, meanwhile no such cases were observed in the first group (p = 0.330).

Kashif Zafar et al., in their study on IMR following acute myocardial infarction, found that the right coronary artery is the most commonly involved artery in myocardial infarctions of the inferior wall, supporting our study results. Complications such as severe IMR are more frequent among patients who have experienced an inferior myocardial infarction dominated by the right coronary artery, compared to those dominated by the left circumflex artery [8].

The characteristics of coronary blood flow in acute myocardial infarction and IMR were also studied by Shun Nishino, Nozomi Watanabe, et al., who found that IMR most frequently occurred in patients with infarct-related lesions of the left anterior descending artery, followed by the right coronary artery [9; 10]. In comparing the incidence of multivessel disease between the two groups in our study, the prevalence was significantly higher in patients with IMR – 57 (56.44%) patients, while 18 (37.50%) patients without IMR had multivessel disease (p = 0.031).

In general, the population examined by Shun Nishino, Nozomi Watanabe et al. represented a slightly different demographic, with a higher incidence of multivessel disease [10; 11], which can be attributed to the older age of patients selected for coronary stenting compared to those in our study.

Therefore, our findings indicate that IMR in the context of acute myocardial infarction was more frequently observed in patients when the infarction was caused by a lesion in the right coronary artery, followed by the circumflex branch of the left coronary artery. The presence of multivessel disease in patients with acute myocardial infarction not only worsens the clinical picture and complicates treatment but also increases the likelihood of developing IMR [12].

In the work of international colleagues Traves D. Crabtree et al. on the impact of IMR on patient survival after surgical treatment, it is noted that mortality due to IMR remains high despite surgical intervention and may be associated with risk factors for the progression of coronary artery disease. Even after recovery, IMR progresses in a considerable number of patients and is associated with lower survival rates [13; 14].

The analysis of the obtained results confirms the relevance of the topic and the importance of timely identification of predictors for the development and early diagnosis of IMR in patients with acute myocardial infarction and reduced left ventricular ejection fraction.

Conclusions

1. According to the data, patients with IMR had a significantly higher incidence of right coronary artery involvement (45.54% vs. 25.00%) and involvement of the circumflex branch of the left coronary artery (33.66% vs. 14.58%) compared to patients without IMR. In contrast, patients without IMR more frequently had involvement of the left anterior descending artery (60.42% vs. 18.81%), indicating an important influence of the infarct-related artery on IMR development during myocardial infarction.
2. Multivessel coronary artery disease was more common among patients with IMR (56.44% vs. 37.50%), suggesting a close association between the severity of coronary disease and the risk of IMR development.
3. The study showed that a longer time to reperfusion (> 12 hours from symptom onset) increases the likelihood of severe IMR. Patients with reperfusion time > 12 hours more frequently had Grade II or III IMR compared to those with earlier blood flow restoration.

There is no conflict of interest.

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Надійшла до редакції 17.11.2024 р.
Прийнята до друку 27.03.2025 р.
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