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ORIGINAL

Diagnostic and therapeutic differences in ST-segment elevation acute myocardial infarction according to sex

Diferencias diagnósticas y terapéuticas en el infarto agudo de miocardio con elevación del segmento ST, según el sexo

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ABSTRACT

Introduction: acute myocardial infarction (AMI) is a manifestation of coronary artery disease, a determinant of mortality for men and women in the fifth decade of life.
Objective: to identify the differences in diagnostic and therapeutic tests according to sex in patients with ST-elevation myocardial infarction.
Method: quantitative, cross-sectional, retrospective investigation in 155 patients, 97 men and 58 women, admitted to Coronary Intensive Care, Institute of Cardiology and Cardiovascular Surgery with ST-segment elevation myocardial infarction, January 2020-December 2021. Variables related to diagnosis and treatment were explored.
Results: on admission, more than 55 % of the patients attended underwent reperfusion treatment, which was a very effective therapy in all cases. Women were more often reperfused by PCI (50 %) and men by thrombolysis (15,5 %). During hospitalization, 77,32 % of men required a second PCI and 52,6 % a PTCA, while 65,52 % of women and 43,10 % of men required a second PCI and 52,6 % a PTCA. 67,7 % (130 cases) with transthoracic ECHO performed were normal, the more severe degrees of involvement of the left ventricular ejection fraction was decreased.
Conclusions: there were diagnostic and therapeutic differences according to sex. The left ventricular ejection fraction was more affected in men and a greater number of altered complements. It is necessary to improve the early identification and management of women with ST-segment elevation myocardial infarction.

Keywords: Acute Myocardial Infarction; Ischemic Heart Disease; Diagnosis; Treatment; Sex.

RESUMEN

Introducción: el infarto agudo de miocardio (IAM) es una manifestación de la enfermedad coronaria, determinante de la mortalidad para hombres y mujeres en la quinta década de la vida.
Objetivo: identificar las diferencias de las pruebas diagnósticas y terapéuticas según sexo en los pacientes con infarto del miocardio con elevación del ST.
Método: investigación cuantitativa, transversal, retrospectiva, en 155 pacientes, 97 hombres y 58 mujeres, ingresados en Cuidados Coronarios Intensivos, Instituto Cardiología y Cirugía Cardiovascular con infarto agudo miocardio con elevación del segmento ST, enero 2020-diciembre 2021. Se exploraron variables relacionadas con el diagnóstico y el tratamiento.
Resultados: al ingreso más del 55 % de los pacientes atendidos, se realizaron algún tratamiento de reperfusión, fue una terapéutica muy efectiva en los casos. Las mujeres fueron más reperfundidas a través de la ICP (50 %)

y los hombres a través de la trombolisis (15,5 %). Durante la hospitalización los hombres requirieron en un 77,32 % una segunda ICP y el 52,6 % una ACTP y las mujeres el 65,52 % y el 43,10 %. El 67,7 % (130 casos) con ECO transtorácica realizada fueron normales, los grados más severos de afectación de la fracción de eyección del ventrículo izquierdo estuvo disminuida.
Conclusiones: existieron diferencias diagnósticas y terapéuticas según el sexo. La fracción de eyección del ventrículo izquierdo estuvo más afectada en los hombres y mayor número de complementarios alterados. Es necesario mejorar la identificación precoz y el manejo de la mujer con infarto agudo de miocardio con elevación del segmento ST.

Palabras clave: Infarto Agudo de Miocardio; Cardiopatía Isquémica; Diagnóstico; Tratamiento; Sexo.

INTRODUCTION

Acute myocardial infarction (AMI) is one of the most critical manifestations of coronary artery disease, a determinant of morbidity, mortality, and disability for men and women in the fifth decade of life, often permanently due to heart failure and/or angina pectoris.[1,2]

AMI is myocardial necrosis that usually occurs as a result of acute obstruction of a coronary artery. Symptoms include chest discomfort with or without dyspnea, nausea, and/or sweating. Diagnosis is based on an electrocardiogram (ECG) and the finding of serological markers. Treatment is with antiplatelet agents, anticoagulants, nitrates, beta-blockers, this time and reperfusion therapy.[3]

In recent decades, ischemic heart disease has occupied a leading position in Cuba, with rates of around 40 % of all deaths, as demonstrated by numerous studies over the years.[4,5]

According to reports from the World Health Organization (WHO), more than 75 % of deaths of cardiovascular origin correspond to ischemic heart disease, which is why it is considered an emerging epidemic in developing countries.[2] During the 20th century, a global revolution occurred, known as the epidemiological transition. This is responsible for the fact that the world's population is living longer, with the consequent appearance of chronic diseases, among which heart disease is one of the leading causes, with variability from one country to another.[6]

Adequate diagnosis and treatment of ST-segment elevation acute coronary syndromes is a priority for cardiology. These actions show behaviors according to the sex of the affected patient. Therefore, the objective is to identify the differences in diagnostic and therapeutic tests according to sex in patients with ST-segment elevation myocardial infarction.

METHOD

This is an observational, retrospective study at the Institute of Cardiology and Cardiovascular Surgery, in the Coronary Intensive Care Unit of the Institute of Cardiology and Cardiovascular Surgery in Havana province, over two years, from January 1, 2020, to December 31, 2021. We worked with a sample of 155 patients, aged 19 years or older, admitted to that service with a diagnosis of ST-segment elevation acute myocardial infarction, of whom 97 were male and 58 female.

We compared the type of reperfusion and treatment performed on admission and later during hospitalization by sex; we also compared the results of percutaneous transluminal coronary angioplasty (PTCA), if applicable, transthoracic ECHO, the pharmacological treatment applied, and the serum analyses presented during hospitalization according to the patient's sex.

Traditional epidemiological studies were used to analyze qualitative variables, and Pearson's Chi-square test was applied to investigate the influence of each characteristic in men and women.

RESULTS

The effectiveness of the therapeutic procedures performed on admission of patients contributes to increasing the survival of those who suffer an AMI. One of the effective treatments is thrombolysis, which can be applied in municipal emergency departments. Thrombolysis, together with percutaneous coronary intervention (PCI), are the practices most commonly used when patients arrive at the Institute of Cardiology and Cardiovascular Surgery (table 1).

More than 55 % of the patients who underwent reperfusion treatment on admission to the Institute of Cardiology and Cardiovascular Surgery. PCI proved to be a very effective therapy in the cases of this study; less than 2 % were failures, and these occurred only in men.

Women were more often reperfused via PCI (50 %) and men via thrombolysis (15,5 %) within each sex group.

Table 1. Admission management of patients with ST-segment elevation AMI, according to sex

Variables	Successful ICP	Failed ICP	Not performed	Deceased who did not perform	Effective thrombolysis	Thrombolysis not effective	Total
Male	36	3	25	10	15	8	97
% of men	55,38	100	58,14	83,33	68,18	80	-
% behavior	37,11	3,09	25,77	10,31	15,46	8,25	-
% cases	23,23	1,94	16,13	6,45	9,68	5,16	62,58
Female	29	0	18	2	7	2	58
% of women	44,62	0	41,86	16,67	31,82	20	-
% behavior	50	0	31,03	3,45	12,07	3,45	-
% cases	18,71	0	11,61	1,29	4,52	1,29	37,42
Total cases	65	3	43	12	22	10	155
of total	41,94	1,94	27,74	7,74	14,19	6,45	-
Statistician		df	p-value				
Pearson's chi-square	7,390807	5	0,19316				
Chi-square M-L	8,793471	5	0,11759				

Legend: PCI percutaneous coronary intervention.

Procedures performed on patients with ST-segment elevation AMI during hospitalization.

During hospitalization, coronary angiography is performed again in order to complete the corrective treatment of the cause of ST-segment elevation AMI.

In addition, PTCA was performed in 49 % of the patients. The results of both procedures are shown in table 2.

Table 2. Performance of coronary angiography and PTCA in patients with ST-segment elevation AMI, according to sex, during hospitalization

Sex	Coronary angiography during admission			PTCA during admission		
	Yes	No	Total	Yes	No	Total
Male	75	8	97	51	46	97
% column	66,37	40	-	67,11	58,23	-
% row	77,32	8,25	-	52,58	47,42	-
% total	48,39	5,16	62,58	32,90	29,68	62,58
Female	38	12	58	25	33	58
% column	33,63	60	-	32,89	41,77	-
% row	65,52	20,69	-	43,10	56,90	-
% total	24,52	7,74	37,42	16,13	21,29	37,42
Total	113	20	155	76	79	155
of total	72,90	12,90	100	49,03	50,97	100
Statistician		df	p-value		df	p-value
Pearson's chi-square	5,058771	2	0,07971	1,303604	1	0,25356
Chi-square M-L	4,884921	2	0,08695	1,306752	1	0,25298

Legend: PTCA, percutaneous transluminal coronary angioplasty.

In the case of coronary angiography, 113 (72,9 %) of the 155 cases in the study were repeated during admission. Men predominated in this study's sample, requiring the procedure more frequently, 77,32 % within

their group and 65,52 % within the group of women.

The difference was not statistically significant, but it was observed that men received more invasive treatment.

The other procedure that shows its results in table 2 is PTCA, with a predominance of the male sex, reflecting the extent of coronary artery disease.

Within the group of men, a higher percentage required the procedure (52,6 %) compared to women (43,10 %). However, the highest rate of patients belonged to the male sex.

Another beneficial procedure for diagnosis is transthoracic ECHO. Its results are shown in table 3.

Table 3. Results of transthoracic echocardiography performed during hospitalization

Sex	Male		Female		Total
	No.	%	No.	%	
ECO performed	82	84,53	50	86,20	132
ECO normal	54	65,85*	34	68*	88
ECO altered	28	34,15*	16	32*	44
Decreased LVEF	17	60,71**	11	68,75**	28
Very low LVEF	11	39,29**	5	31,25**	16
ECO not performed	15	15,46	8	13,79	22
Total	97	-	58	-	155

Legend: ECHO, transthoracic echocardiography; LVEF, left ventricular ejection fraction; *, percentage with respect to the total number of ECHOs performed for that sex; **, percentage with respect to the total number of altered ECHOs for that sex.

Of the 130 cases with transthoracic ECHO performed, 67,7 % had normal results. By sex, 65,9 % of males and 68 % of females were normal, and 34,2 % and 32 % were abnormal.

Of the altered cases, 60,7 % (17 men) and 68,8 % (11 women) had a decreased left ventricular ejection fraction (LVEF). LVEF below 40 was found in 16 patients, 11 men and five women, respectively, for 39,3 % and 31,3 % of the altered cases for each sex group.

Of the total cases, 14,2 % did not undergo the procedure. Of these, 15,5 % of the 97 men and 13,8 % of the women.

All cases were treated with dual antiplatelet therapy and statins (table 4).

Table 4. Treatment indicated for patients with ST-segment elevation AMI during hospitalization, according to sex

Treatment	Treaty		Untreated		Female	Male
	No.	%	No.	%		
Double antiplatelet aggregation	155	100	0	0	58	97
Anticoagulation	124	80	31	20	50	74
Beta-blockers	61	39,35	94	60,65	27	34
Statins	155	100	0	0	58	97
IECA	128	82,58	27	17,42	50	78
Inotropos	34	21,94	121	78,06	12	22
Anticalcics	51	32,90	103	66,45	16	35

The difference in the case of anticoagulation is due to the choice of reperfusion strategy, which was not used in patients who received pharmacological reperfusion with streptokinase.

Beta-blockers were not used in patients with Killip Kimball III and IV; moreover, their use varied according to individual contraindications.

Other less commonly used treatments were anticalcic agents, which were indicated in patients with coronary vasospasm or who were allergic to ACE inhibitors. In the case of inotropes, they were only used in patients with Killip Kimball IV.

There were differences in the application of anticoagulation, oral beta-blockers, ACE inhibitors (angiotensin-

converting enzyme inhibitors), inotropes, and calcium channel blockers.

The study shows the results of the serum complement tests performed on the patients. In men, compared to women, there was a predominance of altered cholesterol (54,55 %), ASAT (71,43 %), CK (74,19 %), CK-MB (85,71 %), uric acid (75 %), and leukocytes (74,2 %). However, in women, hemoglobin (60 %) and blood glucose (59,1 %) were predominantly altered. ALAT had the same altered behavior for both sexes (table 5).

Table 5. Results of complementary blood tests by sex

Serum analysis	Sex						Contingency Analysis		
	Male			Female					
	Altered	Normal	Not performed	Altered	Normal	Not performed	x2 p	df	p-value
Cholesterol	6 54,55 %	76 62,81 %	15 65,22 %	5 45,45 %	45 37,19 %	8 34,78 %	0,374285	2	0,8293
Hemoglobin	6 40 %	76 64,96 %	15 65,22 %	9 60 %	41 35,04 %	8 34,78 %	3,616579	2	0,1639
ALAT	1 50 %	81 62,31 %	15 65,22 %	1 50 %	49 37,69 %	8 34,78 %	0,207597	2	0,9014
ASAT	5 71,43 %	77 61,60 %	15 65,22 %	2 28,57 %	48 38,40 %	8 34,78 %	0,353634	2	0,8379
Blood glucose	9 40,91 %	73 66,36 %	15 65,22 %	13 59,09 %	37 33,64 %	8 34,78 %	5,152844	2	0,0761
CK	23 74,19 %	59 58,42 %	15 65,22 %	8 25,81 %	42 41,58 %	8 34,78 %	2,601693	2	0,2723
CK-MB	6 85,71 %	76 60,80 %	15 65,22 %	1 14,29 %	49 39,20 %	8 34,78 %	1,837276	2	0,3991
Uric Acid	9 75 %	73 60,83 %	15 65,22 %	3 25 %	47 39,17 %	8 34,78 %	1,015132	2	0,6019
Leukocytes	23 74,19 %	59 58,42 %	15 65,22 %	8 25,81 %	42 41,58 %	8 34,78 %	2,601693	2	0,2723

Legend: ALAT, alanine aminotransferase; ASAT, aspartate aminotransferase; CK, creatine kinase; CK MB, brain muscle creatine kinase; , Pearson's Chi-square; df, degrees of freedom.

DISCUSSION

One of the most important advances that Cuba has developed is reperfusion therapy. In recent decades, pharmacological, percutaneous, and surgical reperfusion advances have improved outcomes and prognosis for patients with AMI. However, patients with large AMI or who do not receive timely reperfusion are at risk for mechanical complications of AMI.[6]

Some authors have attempted to explain the observed difference between sexes in revascularization strategies based on biological differences, such as the smaller diameter of coronary vessels observed in women, the higher prevalence of non-obstructive coronary artery disease and the higher frequency of smooth muscle cell dysfunction; however, the differences in the use of revascularization persist after adjusting stratification according to angiographic findings, which would indicate that other factors influence such decisions.[7]

Coronary angiography or coronary angiography is the golden test that offers the possibility of visualizing and treating the diseased artery by means of percutaneous coronary intervention.[8]

A study in Spain analyzed the frequency of reperfusion methods by sex and found that the use of reperfusion (PCI, fibrinolysis and surgical revascularization) was lower in females than in males over 11 years: 56,6 vs. 75,6 % and 36,4 vs. 57 % respectively (both, $p < 0,001$).[9]

Thrombolysis is an effective therapy for a significant number of patients with ST-segment elevation AMI. Of the 32 cases treated at admission in this study, an effectiveness of 68,8 % was observed. A publication from Villa Clara shows a study in which thrombolysis failed in 27 patients (40,9 %).[10]

For the world and especially for Cuba, there is a population whose improvement in survival depends on the success of reperfusion of the artery related to the infarction, using a strategy centered on fibrinolytics. Early recognition, using a noninvasive, simple, and reliable technique, of individuals who may have failed reperfusion with fibrinolytics is vital, since they are at greater risk of developing cardiogenic shock, severe heart failure, lethal arrhythmias, or sudden death.[11]

Mechanical reperfusion is firmly established for patients with symptoms 3 hours or more from onset.

Fibrinolysis is the preferred method of reperfusion in circumstances where easy access to an expert PCI center is not available (prolonged transport time, busy catheterization laboratory, inexperienced technician/team)[12]

In this study, the use of reperfusion treatment during the emergency did not show significant differences, contrary to what was observed in a study in women, where they were less likely to receive invasive treatment and more likely to be treated conservatively.[13] Chávez[5], five however, states that there were no differences in the use of invasive procedures, although he does refer to a lower number of women undergoing reperfusion therapy in general, which could be explained by the decrease in the possibility of thrombolysis due to the delay in going to the medical services.

There is a precedent of an investigation carried out during four years in Havana, in which 49 % of the patients received thrombolytic treatment and 29,9 % underwent primary PTCA. In addition, 3,7 % underwent rescue PTCA and previous thrombolytic treatment. Facilitated PTCA and PTCA in shock were performed in 0,46 %, and 15,7 % were left without reperfusion treatment. The distribution of patients who underwent thrombolysis and primary PTCA during the five years was stable, and thrombolysis predominated in all the study years.[12]

In Peru, research shows that 29 women benefited from the procedure and a higher number of men. This represented, within each group, 34,9 % and 41,5 %.[14]

Angioplasty is the most commonly used technique for revascularization in ST-segment elevation AMI of less than 12 hours' evolution. Primary PTCA should be performed whenever it is possible to perform it within 120 minutes from the time of diagnosis. This technique is superior to fibrinolysis in reducing mortality, the incidence of reinfarction and stroke.[15]

Lower results, in terms of the percentage of patients who underwent PTCA during hospitalization, are shown in other studies. For example, there is a record of a study from Peru that records 29 % of patients already hospitalized.[16]

The echocardiogram helps to determine and detect intraventricular thrombi, cardiac masses (myxoma, papillary fibroelastoma, etc.), vegetations, valvular alterations, plaques in the ascending aorta and right-to-left shunts that can cause coronary embolisms.[17]

Thirty percent of 50 patients referred for angioplasty in Havana in 2020 had a left ventricular ejection fraction below 40.[18]

Some studies suggest that therapeutic requirements differ between men and women.[3] It is recognized that primary percutaneous coronary intervention has demonstrated greater efficacy of coronary reperfusion than pharmacological treatment. However, it is emphasized that the adequate application of the reperfusion strategy requires, in parallel, new antiplatelet and/or anticoagulant treatments, which have led to a slight decrease in mortality in acute coronary syndrome.[3]

Serum markers in ST-segment elevation AMI are useful for establishing the diagnosis and prognosis of the disease, but they are not always available in the services where persons with suspected AMI are attended. Among them, the most sensitive is troponin, as it is a specific enzyme for the diagnosis of infarction.[19]

The use of cardiac troponin (cTn) as the biomarker for evaluating patients with a possible diagnosis of AMI has been recommended for almost twenty years. The correct diagnosis or ruling out of AMI has still been considered a real challenge faced by medical specialists in their respective emergency department units. In clinical practice, this biomarker has been shown to improve the diagnosis of AMI, since its concentration values have been correctly interpreted mainly in the context of the patient's clinical history.[19]

Tissue injury caused by various exogenous or endogenous stimuli gives rise to a complex reaction called inflammation due to the damage caused in the vascularized connective tissue. This vascular reaction results in the accumulation of fluid and leukocytes in the extravascular tissues. The rupture of the atheroma plaque in AMI predisposes to the exposure of substances that help platelet activation and aggregation, in addition to thrombin generation, leading to the formation of a thrombus that hinders blood flow, causing an imbalance and decrease in the supply and requirement of oxygen, finally resulting in myocardial necrosis.[20]

In the next two hours after the onset of the process, the increase of leukocytes begins, reaches its maximum peak 2 to 4 days post infarction, and within a week returns to normal. The maximum peak of leukocytosis usually reaches measurements between 12-15 per 103/mm3, reaching up to 20 per 103/mm3 in extensive infarcts.Fasting hyperglycemia is an important factor in 30-day infarct mortality.[20]

An increase in total leukocytes is an independent risk factor for atherosclerotic disease; leukocytes trigger a series of reactions in phagocytes that promote damage to blood vessels and accelerate atherosclerosis.[5,20]

Hyperglycemia at admission can be observed in patients with acute myocardial infarction, regardless of previous history of diabetes, and is associated with increased mortality. This increased risk could be explained by the larger infarct size, as well as by a higher proportion of heart failure and cardiogenic shock in this population.[20]

In this work, the highest percentage of altered blood glucose occurred in the female sex proportionally in the analysis by sex. In some patients, elevated blood glucose concentration may be a marker of a preexisting, as yet undetected disease, type 2 diabetes, representing increases in lipolysis and an excess of circulating free

fatty acids, more extensive myocardial damage, and even the presence of more severe coronary artery disease. Stress during acute myocardial infarction can elevate blood glucose concentrations in the first hours.[5]

CONCLUSIONS

1. There were diagnostic and therapeutic differences according to sex, with greater demand for invasive reperfusion in women attended at admission, in contrast to reperfusion during hospitalization, when male demand for reperfusion increased.
2. The left ventricular ejection fraction was more severely affected in men, who had a greater number of altered complements, which leads to the creation of programs to change the attitude of health care settings in order to improve the early identification and management of women with ST-segment elevation myocardial infarction.

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None.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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