

Long-Term Prognosis of Patients with Myocardial Bridge and Angiographic Milking of the Left Anterior Descending Coronary Artery

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Introduction. Myocardial bridging with systolic compression (milking) of the left anterior descending coronary artery may be associated with myocardial ischemia. Little information is available about the long-term prognosis of patients with this coronary anomaly.

Material and methods. A review was made of coronary angiographies of patients diagnosed as ischemic heart disease made between 1994 and 1999 in two centers. The long-term follow-up of patients with myocardial bridging and systolic compression of the left anterior descending coronary artery was analyzed. Data were collected by reviewing medical records and completed by telephone interview.

Results. Prevalence: 0.72%. Milking was observed in 60 patients, but 25 of them were excluded due to associated hypertrophic cardiomyopathy, severe valvular disease, or coronary artery disease. The clinical follow-up was available for all patients (median: 43 months, range: 12-80 months). Mean age 55.7 years (SD=11.9). Men 74%. Clinical presentation: angina 26 patients, atypical chest pain with positive non-invasive test 8, acute myocardial infarction 1. During follow-up, 1 patient died of sudden cardiac death. Seven patients continued to present stable angina CCS class I-II, coronary angiography was repeated in 5 patients, and one required percutaneous revascularization for symptoms. In 63% of cases, antianginal drugs were still needed at the end of follow-up period (beta-blockers or calcium antagonists).

Conclusions. Patients with myocardial bridging and systolic compression of the left anterior descending artery have a good long-term prognosis, although more than half of them continue regular treatment with antianginal drugs. In a small percentage of cases percutaneous intervention must be performed and ischemic heart disease may appear in more aggressive forms (acute myocardial infarction or sudden death).

Key words: *Milking. Intramyocardial bridge. Chest pain syndrome. Prognosis.*

Full English text available at: www.revespcardiol.org

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Received 29 March 2001.

Accepted for publication 4 January 2002.

Pronóstico a largo plazo de los pacientes con trayecto intramiocárdico de la arteria descendente anterior con compresión sistólica

Introducción. El trayecto intramiocárdico con compresión sistólica (*milking*) de la arteria descendente anterior puede asociarse a isquemia cardíaca. Existe poca información sobre la evolución a largo plazo de pacientes con esta anomalía coronaria.

Material y métodos. Se revisaron las coronariografías de los pacientes con diagnóstico de cardiopatía isquémica realizadas entre 1994 y 1999 y se analizó la evolución de los pacientes con *milking* de la descendente anterior. El seguimiento se realizó mediante revisión de la historia clínica y se completó con contacto telefónico.

Resultados. Prevalencia: 0,72%. Se observó fenómeno de *milking* en 60 pacientes, de los cuales 25 se excluyeron por miocardiopatía hipertrófica, valvulopatía severa o enfermedad coronaria asociada. Se obtuvo seguimiento clínico en el 100% de los casos (mediana: 43 meses, rango: 12-80). La edad media de los pacientes era de 55,7 años (DE = 11,9) y el 74% eran varones. La forma de presentación clínica fue: angina en 26 pacientes; dolor torácico atípico con isquemia en test no invasivos en ocho, e infarto en uno. Un paciente presentó muerte súbita en el seguimiento. Siete permanecen con angina de esfuerzo grados I-II CCS, la coronariografía tuvo que repetirse en 5 casos y un paciente necesitó revascularización percutánea para controlar los síntomas. En el 63% de los casos los pacientes continúan con tratamiento médico (bloqueadores beta o antagonistas del calcio).

Conclusiones. Los pacientes con trayecto intramiocárdico y *milking* de la descendente anterior tienen buen pronóstico a largo plazo, aunque más de la mitad continúan utilizando medicación de forma crónica. En un pequeño porcentaje de casos se necesita revascularización percutánea y la cardiopatía isquémica se puede presentar en sus formas más agresivas (infarto o muerte súbita).

Palabras clave: *Milking. Puente intramiocárdico. Dolor torácico. Pronóstico.*

INTRODUCTION

The segments of coronary artery that penetrate the myocardial tissue and are surrounded by muscular fibers are known as intramyocardial bridges.^{1,2} These segments can greatly decrease in caliber during the systole, an effect known as «milking», due to the external pressure of the myocardial fibers on the artery. Flow to the distal segment of the artery can be reduced, triggering myocardial ischemia. There is little information in the literature about the prognosis of patients with this anomaly. The purpose of this study was to analyze the long-term outcome of patients with intramyocardial bridges and systolic milking effect.

MATERIAL AND METHODS

Patients

Patients were obtained from the registries of existing procedures kept at the two hemodynamics laboratories that participated in the study. These two laboratories are reference centers for their respective provinces. Because of the different possibilities of the two computerized systems and the retrospective way in which patients were located, the analysis in center 1 corresponds to the period from January 1994 to December 1998, and in center 2 to the period from January 1996 to December 1999.

Patients were selected initially from among the patients referred to the two laboratories for suspected coronary artery disease. Of these patients, we selected those in which the laboratory records indicated the presence in the coronary angiography of an intramyocardial segment («bridge») of anterior descending coronary artery with systolic compression («milking»).

The coronary angiographies and medical history were reviewed in the patients initially selected, who were the object of follow-up, and the study was made in the patients who met the inclusion criteria established in the course of the study design.

Inclusion criteria

The patients who met two criteria were included in the study: *a*) existence of systolic compression of the anterior descending coronary artery that produced more than 50% stenosis of the arterial lumen, confirmed by manual measurements or quantitative analysis, depending on the capacity of the laboratory at the time of the study, and *b*) absence of cardiac pathology capable of producing anginal symptoms.

The last criterion was obtained from the patients' medical history in both hospitals. The patients who, in addition to suspected coronary artery disease as the initial indication, had a diagnosis of moderate or severe

aortic stenosis, moderate or severe left ventricular hypertrophy of any origin, or hypertrophic cardiomyopathy were excluded. Patients with coronary artery disease, understood as fixed stenosis of more than 50% at some point of the coronary tree, were also excluded.

Coronariography technique

Since patients were included in the study on the basis of a coronary angiography made before the study was designed, there was no established protocol for the coronary angiography. Even so, the operating protocol of both laboratories systematically included the 30° RAO, 30° cranial, and 90° LAO views, in which the phenomenon of systolic compression of the anterior descending coronary artery could be observed clearly. This protocol included the absence of intracoronary nitroglycerin administration until a fixed coronary stenosis or more than 60% of the vessel caliber was appreciated visually.

Follow-up

Follow-up was carried out by telephone and completed with a review of the medical histories of the patients who had new admissions and medical records at one of the hospitals where the study was made. The clinical situation of patients, medical treatment at time of follow-up, and events experienced (death, myocardial infarction, need to repeat coronariography, or revascularization) were analyzed for the follow-up period.

RESULTS

In the preliminary selection of patients, 8333 patients were detected that had been sent to one of the two centers for coronary angiography due to suspected ischemic heart disease. Of them, 60 patients presented systolic compression of more than 50% of the anterior descending coronary artery in the coronariography. Of these 60 patients, 25 presented associated cardiac pathology (hypertrophic cardiomyopathy in 13 cases, coronary artery disease in 8, and severe aortic valve disease in 4) and were excluded from follow-up. The total prevalence among the patients referred for suspicion of ischemic heart disease was 0.72%. After the patients with associated cardiac pathology were excluded, the prevalence was 0.42%.

The mean age of patients was 55.7 years (SD=11.9 years). The distribution by sexes showed a male predominance (74%). One patient had diabetes, which was controlled with oral medication; 4 had arterial hypertension; 12 had hypercholesterolemia; and another 12 were active smokers at the time that coronary an-

giography was ordered.

The clinical presentation was stable angina in 19 cases, unstable angina in 7, atypical chest pain with inducible ischemia in noninvasive tests (conventional exercise stress testing, radionuclide perfusion study, or stress echocardiogram) in 8 cases, and acute anterior myocardial infarction in 1 case (Table 1). In 15 cases (43%) disturbances were detected on the anterior face in external recordings, such as the electrocardiogram, thallium scan, or effort or dobutamine echocardiogram.

The mean ventricular fraction was 61%. Moderate ventricular dysfunction was found in only one case, the one that presented as acute myocardial infarction.

All of the patients were followed-up clinically. The median follow-up was 43 months (range: 12-80 months). During this interval one patient died suddenly. At the end of follow-up, 7 patients presented grade I-II CCS effort angina in spite of medical treatment, the coronariography had to be repeated in 5 patients, and in 1 case percutaneous revascularization and stent implantation were performed in the zone of systolic compression. In 63% of the cases, patients continued to use antianginal medication. Beta-blockers were the medication most frequently taken (19 patients, or 86% of the patients who required treatment), followed by diltiazem (3 patients, 2 due to contraindication for beta-blocker use, and one for poor symptom control). The results of the follow-up are described in Table 2.

DICUSSION

Intramycardial bridges are a relatively frequent finding in the activity of hemodynamics laboratories. They are diagnosed in clinical practice by angiography and have an incidence of 0.5%-2.5%. However, in post mortem samples their frequency of occurrence is much higher (15%-85%). This disparity is due to the fact that angiography easily detects cases of intramycardial segments with a systolic compression effect, or milking, but not cases in which milking is absent. The wide variability in incidence in different anatomopathological series seems to depend on the skill of the personnel performing the dissection.¹

The angiographic appearance depends on the thickness and length of the intramycardial segment, the reciprocal orientation of the artery and muscle fibers, and the nature of the tissue interposed between them.² During coronary angiography, the milking effect may be accentuated by the administration of intracoronary nitroglycerin.³ In our study, intracoronary nitroglycerin was not administered systematically in either laboratories, except when a possible reduction in vessel diameter was detected in some point in the coronary

TABLE 1. Clinical characteristics of patients

	Number	Percentage (%)
Patients	35	
Age	55.7 (SD=11.9)	
Males	26	74
NIDDM	1	2.9
AHT	4	11.5
Cholesterol	12	34
Smoking	12	34
Presentation		
Angina	26	74.3
AMI	1	2.9
Positive test	8	22.8

NIDDM indicates non-insulin-dependent diabetes mellitus; AHT, arterial hypertension; AMI, acute myocardial infarction.

TABLE 2. Clinical follow-up

	Number	Percentage (%)
Patients	35	
Follow-up	43 months	
Sudden death	1	2.9
Angina	7	20
Repetition of coronariography	5	14.3
Percutaneous revascularization	1	2.9
Chronic medication	22	63

tree. This is probably the reason why we found a lower prevalence than has been reported in other studies.

The segments most affected are the proximal and middle thirds of the anterior descending coronary artery, although cases have been described in the diagonal and marginal branches and in the right coronary artery.⁴ It is considered to be a congenital pathology, although an acquired case has been described,⁵ probably derived from the increment in myocardial mass with time. It is associated with other cardiac pathologies, fundamentally hypertrophic cardiomyopathy.^{6,7}

The existence of atherosclerotic disease in the intramycardial segment is infrequent,^{8,9} and it has even been claimed that these segments protect against atheroma formation. This protective effect can be due to the abolition of the pulsatile nature of blood flow through the intramycardial segments. Nevertheless, in the previous segment it is not infrequent to find moderate degrees of coronary stenosis, which can be a consequence of the tension produced on the vessel wall by the turbulence of the arterial flow at the entrance to the bridge.

Ferreira et al¹ differentiate two types of intramycardial segments: superficial and deep. Only deep segments can be associated with ischemia because they are the only segments that present the milking pheno-

menon. Although arterial compression takes place during systole, it has been confirmed with IVUS studies^{10,11} and Doppler probes¹² that these patients do not have an adequate coronary flow in the first third of the diastole.¹¹ This is due to the existence of a delay in muscle relaxation, which keeps the artery from reaching its normal reference diameter. The final consequence is that these patients present a decreased reserve of coronary flow and a lower-than-normal ischemia threshold. In most cases this flow reserve is sufficient in baseline situations and ischemia is only manifested in situations of increased oxygen demand like exercise,¹³ pacing-induced tachycardia,¹⁴ or stress produced by anesthesia.

It is not clear if a relation exists between degree of reduction in vessel diameter during systole and the clinical symptoms, because some studies indicate that such a relation exists,^{15,16} whereas others have not found it.^{17,18}

Most of the cases are asymptomatic, which explains why the frequency of the anomaly in post mortem study samples is much higher than in angiographic diagnoses. In symptomatic cases, angina, both stable and unstable, is the most common form of presentation.¹⁹ In our series, 74% of the total group of patients were symptomatic. It can also begin as myocardial infarction,^{20,21} ventricular arrhythmias, or sudden death.²² These more serious forms often are related to prolonged ischemia or thrombosis of the intramyocardial bridge.^{23,24} On occasions, milking causes zones of segmental hypokinesia due to a phenomenon of myocardial stunning.

In cases in which intramyocardial coronary segments are associated with myocardial ischemia, there are several therapeutic options available. The medications of choice are beta-blockers, whose mechanism of action is through a negative inotropic and chronotropic effect. Although it has been demonstrated that intracoronary nitroglycerin increases the milking effect in angiography,³ slower-acting nitrites sometimes are beneficial in reducing the preload and inhibiting vasospasm.²⁵ The role of the calcium antagonists is not clear and they are not drugs of first choice, but cases refractory to the beta-blockers that responded to diltiazem have been reported.²⁶ The use of dihydropyridine derivatives alone should be avoided because these drugs can increase heart rate and aggravate clinical manifestations as a result of their hypotensive effect. The duration of the need for medical treatment is a point that has not been studied in any series. In our series, due to the origin of the patients from different centers and how the data was obtained from catheterization laboratories and telephone interviews, all that we can say is that 63% of the patients continued to use beta-blockers or calcium antagonists. It was not possi-

ble to determine what percentage of patients really required medication because many continued regular treatment for purposes of prevention, under instructions from the cardiologist attending the patient.

Sometimes medical treatment is insufficient and other interventions are required. The results of balloon angioplasty are unsatisfactory, because elastic recoil limits the control of symptoms. Klues et al²⁷ describe the implantation of intracoronary stents in 12 severely symptomatic patients, which corrected the flow parameters, as measured by Doppler guidewire. In our series, stent implantation was necessary in one case, in a 48 year-old man with effort angina refractory to medical treatment and ischemia demonstrated by thallium in the territory of the anterior descending coronary artery. This patient has been followed up with periodic check-ups for 28 months and has remained asymptomatic throughout the follow-up period. The exercise stress test made 6 months after revascularization was normal and it has not been necessary to repeat the coronariography.

As a surgical alternative, myectomy can be performed to relieve peripheral pressure on the vessel^{28,29} and cases have been described of revascularization using internal mammary artery.³⁰

Few series have described the long-term prognosis of these patients. In our study, only one of the 35 patients died of cardiac causes in the follow-up period. These findings coincide with those obtained by Kramer et al³¹ and Juilli re et al.¹⁷ In spite of reports of cases of ventricular arrhythmias, myocardial infarction, and sudden death, intramyocardial bridges with a systolic milking effect can generally be considered a relatively benign pathology. Nevertheless, in spite of the low rate of events, these patients often continue medical treatment for prolonged periods, even indefinitely. Up to 63% of the patients in our study continued treatment with medication at the end of follow-up, and the coronary angiography had to be repeated in 5 patients. Based on the good long-term prognosis of this anomaly, percutaneous and surgical techniques should be reserved exclusively for severely symptomatic patients who cannot be treated satisfactorily with oral medication.

LIMITATIONS

In this article we tried to describe the long-term prognosis of patients with intramyocardial bridge of the anterior descending coronary artery and systolic milking. In this retrospective study the patients have been included from the databases of cardiac catheterization laboratories that act as reference centers for a total of 15 hospitals.

As the patients were selected from catheterization

laboratories in which the hemodynamics specialist simply performed a diagnostic test instead of acting as a clinician, it was not possible to make uniform noninvasive diagnostic tests in all the patients. We only can indicate the number of patients in which these tests were performed and the type of tests that were carried out.

Finally, the criteria on which the decision to maintain long-term treatment were based are also beyond the reach of this study and much influenced by the criterion of the cardiologist attending the patient. In some cases therapy was really necessary, in some it was maintained for preventive purposes, and in others the patient preferred to continue therapy.

CONCLUSIONS

Patients with intramyocardial bridges and systolic milking phenomenon in the anterior descending coronary artery have a good long-term prognosis. Nevertheless, 60% require long-term administration of antianginal medication. In a small percentage, ischemic heart disease is manifested in its more aggressive forms (myocardial infarction or sudden death). Revascularization should be considered only in severely symptomatic cases that cannot be controlled with oral medication.

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