

Changes in Myocardial Function and Perfusion after Acute Myocardial Infarction

Isabel Coma-Canella

Departamento de Cardiología y Cirugía Cardiovascular, Clínica Universitaria, Facultad de Medicina, Universidad de Navarra, Pamplona, Spain

Ligation of a coronary artery causes myocardial necrosis. It has been shown in experimental animals¹ that the size of the necrotic scar is directly proportional to the time elapsed between ligation and reperfusion. Early reperfusion not only reduces the size of the infarct, but also protects against ventricular dilatation. Although delayed reperfusion is unable to save the damaged myocardium, it has a positive influence on ventricular remodeling. In such cases, the ventricle is more dilated than it is in animals that have undergone early reperfusion, but less so than in animals whose arteries are permanently occluded. When coronary occlusion is permanent, the infarcted zone becomes thinned and expands, but neither occurs when reperfusion takes place early. A thick scar can lead to less systolic thickening and less oxygen demand, since ventricular stress is inversely proportional to the thickness of the wall. This explains why there is less expansion when reperfusion has occurred than when it has not occurred.

In 1982, Wackers² found by using isotope ventriculography that there were important fluctuations in left ventricular ejection fraction over the first 24 hours after an acute myocardial infarction. Between the measurement taken within the first 6 hours and the repeat measurement 24 hours after onset, ejection fraction can increase or decrease substantially. In the first few hours after an infarct, dynamic and apparently unpredictable changes in left ventricular function take place, making it difficult to assess different therapeutic interventions.

SEE ARTICLE ON PAGES 438-44

Correspondence: Dra. I. Coma-Canella
Departamento de Cardiología, Clínica Universitaria de Navarra
Avda. de Pío XII, 36, 31008 Pamplona, Spain
E-mail: icoma@unav.es

Full English text available at: www.revespcardiol.org

A study by Tamaki³ using isotopic ventriculography also shows important variations over the first 10 days after an infarct. Regional contractility shows greater improvement among patients with single-vessel disease than among those having multi-vessel involvement. Among patients with single-vessel disease, improvement is greater in those whose lesions are in the right coronary artery or the circumflex artery rather than in the anterior descending artery.

The first studies that were performed after the advent of fibrinolysis used echocardiography to assess the beneficial effect of reperfusion.⁴ Patency of the artery that caused the infarct several days after fibrinolysis was associated with improved ventricular function and attenuated dilatation of the chamber. It was soon confirmed that mortality among patients who underwent fibrinolysis decreased more than expected owing to preserved ventricular function. It is a well-known fact that patients who are treated with fibrinolytic agents have significantly lower mortality than comparable patients who do not receive such agents, regardless of the ejection fraction they attain. This underscores the importance of myocardial reperfusion not only for saving viable tissue, but also for preventing the complications that are associated with ventricular remodeling. With primary angioplasty, reperfusion is more complete and effective than with fibrinolysis, and TIMI (angiographic thrombolysis in myocardial infarction) flow grade 3 is more frequently attained. However, when the results of primary angioplasty and of fibrinolysis⁵ are compared, it appears that six-month mortality is lower among those treated with angioplasty, mostly due to a reduced frequency of recurrent infarcts. However, ejection fraction is similar in both groups.

In the study published in the current issue of REVISTA ESPAÑOLA DE CARDIOLOGÍA by Candell Riera et al,⁶ left ventricular function show significant improvement from the hospital discharge until one year later in the total group of 74 patients with acute myocardial infarction, of whom only 40% underwent fibrinolysis and none was treated

with primary angioplasty. Improvement is noted in the subgroup of patients whose infarcts were located in the inferior/lateral part of the heart, rather than in the anterior portion. These findings are consistent with Tamaki's.³

The authors⁶ find no significant differences in the results obtained with ergometric tests and gated single-photon emission tomography (gated SPECT) in patients who received fibrinolytic treatment and in those who did not. This seems to occur one year after infarct onset, though it is not expressly stated, nor are the results of these same tests at the time of discharge (6-8 days after onset) given for subgroups of patients with and without fibrinolysis. It is possible that the influence of fibrinolytic therapy on ventricular remodeling is seen primarily during the first week after the infarct,⁷ before the first tests are performed.

In the aforementioned study,⁶ ejection fraction after one year increased in the 35 patients who did not undergo fibrinolytic therapy, in the 46 who were treated with beta blockers, and in the 61 patients who were not being treated with angiotensin-converting enzyme inhibitors in the second study. The authors do not state whether the findings were significantly different when compared to the opposite subgroups, namely patients who underwent fibrinolysis, those who did not receive beta blockers, and those who were treated with angiotensin-converting enzyme inhibitors. Since in the statistical analysis they do explain that these subgroups of patients are compared to each other, one can assume that differences were noted. It would have been interesting to know the results for each subgroup.

It is possible that, in patients who received fibrinolytic therapy, any improvement that may have occurred in volumes and ejection fraction occurred earlier (between hospitalization and discharge) than in patients who did not undergo fibrinolysis, in whom changes take place at a later time if spontaneous reperfusion occurs at all. Once again, no data are provided for gated-SPECT (ejection fraction, volumes, ischemia and perfusion indexes) in patients who had and had not undergone fibrinolysis, either at the time of discharge or one year after the event.

The fact that ejection fraction increases late in the subgroup of patients who were not treated with fibrinolysis can be attributed to delayed spontaneous reperfusion in a large percentage of cases, either because endogenous fibrinolysis of the occluding thrombus takes place or because of collateral circulation is developed. Even though coronary angiography was performed in 25 patients, the results are not given, making it impossible to confirm if the hypothesis is true.

It is probable that thrombolytic therapy and delayed patency of the artery that caused the infarct play independent and complementary roles in preserving ventricular size and function. According to a study by Popovic,⁷ the effect of fibrinolysis on the size and

function of the left ventricle can be seen in the first phases of the acute myocardial infarction. The changes that take place later are due primarily to the patency of the artery that caused the infarct. This can explain the delayed improvement in the size and function of the ventricle in patients who have not undergone fibrinolytic treatment.

Left ventricular dysfunction secondary to acute myocardial infarction can result from three conditions: a non-viable necrotic myocardium, a stunned myocardium, and a hibernating myocardium. Even though clear-cut criteria do exist that make it possible to distinguish among these three⁸, in practice doing so is not always easy. The study performed by Candell-Riera et al.,⁶ who look at how ventricular perfusion and function evolve over time in the same group of patients, might cast light on the reasons for the dysfunction and for the changes it shows at a later stage.

The perfusion study indicates that throughout the course of one year there is a reduction in the size of the necrotic zone (the perfusion index improves in the infarcted area) in inferior/lateral infarcts, but not in those of the anterior wall. Ischemia remains unaltered during that time, no matter where the infarct is located. Insofar as the size and function of the ventricle are concerned, significant improvement in systolic volume and ejection fraction is seen only in inferior/lateral infarcts, but not in those located in the anterior wall.

The well-established differences between anterior and inferior/lateral infarct are due to the fact that anterior infarcts are normally larger, since the anterior descending artery supplies blood to the greater part of the left ventricular myocardium. In fact, diastolic and systolic volumes in the first study are greater, and the ejection fraction lower, when infarcts are anterior rather than inferior. Strangely, however, perfusion indexes at rest, which reflect the size of the infarct, are smaller (we do not know if significantly so or not) in the case of anterior infarcts than inferior/lateral ones, when logic dictates that they should be larger. The authors fail to explain this contradictory finding.

The authors conclude that left ventricular perfusion as well as left ventricular systolic function improve after one year in more than half the patients who suffer an inferior/lateral infarct and in a small percentage of those with an anterior infarct, perhaps due to improved macro- and microvascular blood flow. Discrepancies between the size of the infarct and ventricular function still need to be explained. Perhaps the same authors will resolve these issues in future studies by applying the same technique in a greater number of patients and by performing coronary angiography on all of them. Both their professional prestige and their research skills make it very likely that they will accomplish this.

REFERENCES

1. Hale SL, Kloner RA. Left ventricular topographic alterations in the completely healed rat infarct caused by early and late coronary artery reperfusion. *Am Heart J* 1988;116:1508-13.
2. Wackers FJ, Berger HJ, Weinberg MA, Zaret BL. Spontaneous changes in left ventricular function over the first 24 hours of acute myocardial infarction: implications for evaluating early therapeutic interventions. *Circulation* 1982;66:748-54.
3. Tamaki N, Yasuda T, Leinbach RC, Gold HK, McKusick KA, Strauss HW. Spontaneous changes in regional wall motion abnormalities in acute myocardial infarction. *Am J Cardiol* 1986;58:406-10.
4. Siu SC, Niforf SM, Galambos GS, Weyman AE, Picard MH. The effect of late patency of the infarct-related coronary artery on left ventricular morphology and regional function after thrombolysis. *Am Heart J* 1992;124:265-72.
5. Zijlstra F, Beukema WP, Van't Hof AW, Liem A, Reiffers S, Hoorntje JC, et al. Randomized comparison of primary coronary angioplasty with thrombolytic therapy in low risk patients with acute myocardial infarction. *J Am Coll Cardiol* 1997;29:908-12.
6. Candell-Riera J, Pereztol-Valdés O, Oller-Martínez G, Llevadot J, Aguadé-Bruix S, Castell-Conesa J, et al. Evolución de la función sistólica y de la perfusión miocárdica valoradas mediante *gated* SPECT durante el primer año después de un infarto agudo de miocardio. *Rev Esp Cardiol* 2003;56:438-44.
7. Popovic AD, Neskovic AN, Babic R, Obradovic V, Bozinovic L, Marinkovic J, et al. Independent impact of thrombolytic therapy and vessel patency on left ventricular dilation after myocardial infarction. Serial echocardiographic follow-up. *Circulation* 1994;90:800-7.
8. Canty JM Jr, Fallavollita JA. Chronic hibernation and chronic stunning: a continuum. *J Nucl Cardiol* 2000;7:509-27.
9. Warren SE, Royal HD, Markis JE, Grossman W, McKay RG. Time course of left ventricular dilation after myocardial infarction: influence of infarct-related artery and success of coronary thrombolysis. *J Am Coll Cardiol* 1988;11:12-9.