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Recovery of global systolic function after primary angioplasty. Influence of coronary flow velocity reserve measured by transthoracic echocardiography☆

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Abstract

Background: Our objective were to know whether coronary flow velocity reserve measured by transthoracic Doppler echocardiography, as marker of microvascular integrity, affects the recovery of global systolic function. Secondly, we intended to define the best cut-off point of coronary flow velocity reserve to predict recovery of global systolic function.
Methods: We studied 57 patients with coronary flow recorded by transthoracic Doppler echocardiography, after suffering a first anterior acute myocardial infarction and undergoing a successful primary percutaneous coronary intervention (TIMI 3 flow). We measured, at discharge and at 1 month: ejection fraction, volume indexes and anterior wall motion score index. Coronary flow in left anterior descending artery was detected by transthoracic Doppler echocardiography and coronary flow velocity reserve was calculated.
Results: After applying ROC curves, 1.54 was the best cut-off value of coronary flow velocity reserve for detection of recovery of global systolic function. Ejection fraction only increased significantly in patients with normal coronary flow velocity reserve. Only end-systolic volume index increased significantly at 1 month in patients with impaired coronary flow velocity reserve.
Conclusion: We showed that coronary flow velocity reserve, measured by transthoracic Doppler echocardiography, influence the recovery of global systolic function, mainly by ventricular dilation. Furthermore, a quite lower value of coronary flow velocity reserve than that used for diagnostic purpose should be used to predict improvement of systolic function.

Keywords: Coronary microcirculation; Doppler echocardiography; Acute myocardial infarction; Coronary flow velocity reserve; Left anterior descending artery

1. Introduction

Primary percutaneous coronary intervention is the preferred method to treat patients with acute myocardial infarction because of the more frequent complete restoration of epicardial blood flow [1–3]. However, despite a patent coronary artery, recovery of both regional and global left ventricular systolic function can be limited, due to damage in microvascular circulation [4–7]. Though normalization of microvascular flow usually improves regional systolic function [8], recovery of global left ventricular systolic function also depends on other mechanisms that can be related to microvascular damage [9]. Moreover, microvascular injury is also associated to a poor prognosis after acute myocardial infarction [7,10,11].

Among several diagnostic tests used to measure the amount of microvascular injury after an acute myocardial infarction, most evidence comes from invasive techniques, especially coronary angiography [10,12], Doppler flow wire [13,14] and myocardial contrast echocardiography with

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intracoronary injection of sonicated microbubbles [15]. Nevertheless, intracoronary Doppler-derived coronary flow reserve seems to be the best predictor for recovery of global and regional left ventricular systolic function [16].

So it would be interesting to have a noninvasive method to measure microvascular injury. Recently, new ultrasound systems have implemented high-frequency transducers that allow both to detect coronary artery flow and to measure coronary flow velocity reserve noninvasively [17]. The agreement between intracoronary and transthoracic measurements of coronary flow velocity reserve is high [18].

Our first objective was to know whether coronary flow velocity reserve measured by transthoracic Doppler echocardiography after primary percutaneous coronary intervention affects the recovery of global left ventricular systolic function. Secondly, we intended to define the best cut-off point of coronary flow velocity reserve to predict recovery of global left ventricular systolic function.

2. Methods

2.1. Study population

For the purpose of this prospective study, we studied 63 consecutive patients who suffered a first anterior acute myocardial infarction without complications and underwent a successful primary percutaneous coronary intervention. Primary percutaneous coronary intervention was defined as angioplasty and/or stenting without prior or concomitant fibrinolytic therapy in patients with history of chest pain/discomfort of <12 h and associated with ST-segment elevation (greater than 0.1 mV in two or more contiguous leads) or (presumed) new bundle–branch block on the ECG [2]. We considered primary percutaneous coronary intervention as successful when TIMI grade 3 flow was obtained in the culprit vessel.

Exclusion criteria were as follows: previous anterior myocardial infarction, atrial fibrillation and contraindication to administer dipyridamole (second- or third-degree atrioventricular block, sinus node abnormality, severe chronic obstructive pulmonary disease, or bronchospasm). Patients refrained from consuming both long-term theophylline and xanthin-containing food and beverages during the 24 h prior to transthoracic Doppler echocardiography. The antiischemic and antiplatelet therapies installed were that considered appropriate by the physician responsible for each individual patient. All patients gave informed and written consent. The research protocol was approved by the locally appointed ethics committee. The study complied with the Declaration of Helsinki.

2.2. Transthoracic doppler echocardiography

Transthoracic Doppler echocardiography was performed with a SONOS 5500 ultrasound system (Philips, Andover, Massachusetts) using a S12 high-frequency transducer (5 to 12 MHz). We used Simpson's biplane method to measure, both at discharge and at 1 month: left ventricular end-diastolic volume, left ventricular end-systolic volume and left ventricular ejection fraction. Left ventricular volumes was corrected by body surface area to obtain volume indexes. Echocardiographic data were analyzed by an experienced operator who had no knowledge of the previous echocardiographic results. Recovery of global left ventricular systolic function was defined as the improvement of left ventricular ejection fraction more than 5 points between measurement at discharge and at 1 month [19].

Left ventricular wall motion score index was analysed according to the 16 segment model of the American Society of Echocardiography [20]. For assessing regional wall motion in the left anterior descending artery territory, nine segments (basal anteroseptal, basal anterior, midinterventricular septum, midanteroseptal, midanterior and four apical segments) were assigned to the left anterior descending artery territory. Wall motion was scored as follows: 1 = normal, 2 = hypokinetic, 3 = akinetic, and 4 = dyskinetic. An anterior wall motion score index was calculated as an average of the wall motion scores in those 9 segments.

For detecting flow in left anterior descending artery, echocardiographic images were obtained from the acoustic window around mid-clavicular line in the fourth and fifth intercostal spaces in the left lateral decubitus position. After the lower portion of the interventricular sulcus had been located in the long-axis cross section, the ultrasound beam was rotated laterally, visualizing the distal portion of the left anterior descending coronary artery under high frequency (5 MHz) color Doppler technique [17]. For color Doppler echocardiography, the velocity range was set in the range of ±15 cm/s to ±19 cm/s, and depth was adjusted at 7 cm. Blood flow velocity was measured by pulsed wave Doppler echocardiography (frequency 5 MHz), using a 1.9 mm sample volume. We tried to align the ultrasound beam direction with the distal left anterior descending artery flow as parallel as possible. All studies were continuously recorded on super-VHS videotape, and clips were also stored digitally on magneto-optical disks for off-line analysis.

An echocardiographic contrast agent (SonoVue, Bracco, The Netherlands) was used to enhance visualization of the Doppler signals. We administered an intravenous bolus of 1 ml of the dilution proposed by the manufacturer. At the time of this investigation, SonoVue was approved for patients with an acute myocardial infarction.

2.3. Measurement of coronary flow velocity reserve

Measurement of coronary flow velocity reserve was performed at discharge. We recorded spectral Doppler signals of distal left anterior descending artery at baseline and at 10 min after starting an infusion of dipyridamole (0.84 mg/kg IV over 6 min). The position of the transducer