

Coronary Flow Velocity Reserve and Myocardial Contractility Under Stress in the Post-Infarction Ischemic Memory Dilemma

Reserva de Velocidade de Fluxo Coronariano e da Contratilidade Miocárdica sob Estresse no Dilema da Memória Isquêmica Pós-Infarto

Marília Esther Benevides de Abreu¹, Tereza Cristina Diógenes Pinheiro¹, Antônio Augusto Lima Guimarães², José Sebastião de Abreu¹⁻³

Clinicárdio Métodos Diagnósticos de Fortaleza¹, Fortaleza, CE, Brasil. Universidade Federal do Ceará², Fortaleza, CE, Brasil. Universidade Estadual do Ceará³, Fortaleza, CE, Brasil.

Introduction

After acute myocardial infarction (AMI), some cases progress with deep T wave inversions on electrocardiogram (ECG). This electrocardiographic abnormality can continue for a prolonged period, even if a coronary intervention within a short time of AMI progression results in successful myocardial reperfusion. However, these deep T wave inversions can raise management questions when the patient is already being followed up in an outpatient clinic, particularly in the absence of relevant symptoms to support the resurgence of an ischemic process. In this context, a safe noninvasive assessment such as dobutamine stress echocardiography (DSE) associated with the analysis of coronary flow velocity reserve (CFVR) may be an option for this dilemma between myocardial ischemia and the possible post-infarction ischemic memory.¹⁻³

Case report

A 59-year-old man with hypertension and dyslipidemia presented with intense oppression, retrosternal burning, and AMI. After approximately one hour of progression, he underwent a hemodynamic study that identified a proximal anterior descending coronary artery (ADA) occlusion (Figures 1A, 1B); the other coronary arteries were normal. The ADA became completely patent after stent implantation with *Thrombolysis in Myocardial Infarction* (TIMI) 3 without blushing (Figure 1C). Forty days after the AMI, the patient attended a cardiology appointment. He had been told about the ECG changes in a previous appointment and was unsure about to which restrictions he would be subjected. He reported mild nonspecific chest pain unrelated to exertion. A physical examination revealed good general condition, eupneic, normal pulmonary auscultation, regular rhythm in three heart beats by the fourth heart sound, and a blood

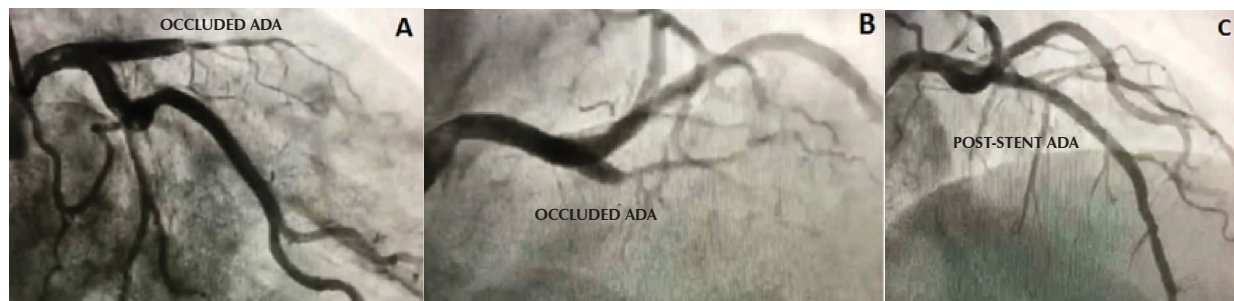


Figure 1 – Coronary angiography showing ADA occlusion (A, B) and complete arterial patency after stent implantation (C). ADA, anterior descending coronary artery

Keywords

Stress echocardiography; Dobutamine; Myocardial infarction.

Mailing Address: José Sebastião de Abreu •

Rua Dr. José Lourenço, 500, apto. 700, Meireles. CEP 60115280 – Fortaleza, CE, Brazil.

E-mail: jsabreu@cardiol.br/jsabreu10@yahoo.com.br

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pressure of 130/70 mmHg. The patient used beta-blockers, aspirin, diuretics, rosuvastatin, and ticagrelor.

An ECG performed before the AMI showed normal ventricular repolarization, while the current test showed deep T wave inversion in the anterior wall (Figure 2A). New tests showed a normal blood count, renal function, and electrolyte, creatine kinase-MB, troponin, and lactate dehydrogenase levels. Echocardiography showed mild concentric left ventricular hypertrophy and normal valves and pericardium. Myocardial hypocontractility was present in the ADA territory, but this vessel had prominent predominant diastolic flow with normal Doppler velocity (Figure 3A). As this coronary artery was patent and the patient had no relevant symptoms, a DSE with simultaneous noninvasive CFVR assessment was proposed. The patient was informed of the benefits and risks of this procedure, which was programmed after his consent.

On DSE, dobutamine was administered in continuous intravenous infusion at doses of 10, 20, and 30 $\mu\text{g}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ in three-minute stages, with atropine 0.5 mg being administered in the third stage and reaching maximum heart rate (HR) (220 - age in years). At this point, the test was concluded and a bolus of 3 mg of esmolol was administered intravenously and later repeated to return the HR to baseline levels.^{1,2} ADA flow was checked intermittently to reach a diastolic velocity twice as high as that at baseline to determine a normal CFVR (≥ 2).³⁻⁵ It should be noted that this normal coronary reserve was obtained early (HR = 98 bpm), i.e., at only 61% of the maximum test HR (Figure 3B). During DSE, the contractile response became normal (Video) without complications or symptoms. During the test, ECG showed T wave polarity normalization (Figure 2B).

Discussion

The demonstration of post-infarction ischemia can be challenging in specific conditions, especially in the absence of

relevant clinical signs, showing the need to rule out differential diagnoses to improve safety regarding life risk or restrictions on the patient's daily activities.

Laboratory test findings were incompatible with myocardial injury, and no pericardial involvement was identified on echocardiography. Increased wall thickness can indicate a noticeable ventricular repolarization abnormality such as in asymmetric septal hypertrophy, apical hypertrophy, or Fabry disease; however, in this case, the hypertrophy was concentric and mild.

DSE is a safe and well-established test for coronary heart disease diagnosis and prognosis. Dobutamine also acts as a potent vasodilator, enabling a validated CFVR assessment. This is obtained by simply dividing the peak diastolic velocity obtained during stress by the one recorded at rest in the ADA flow, with a cutoff point ≥ 2 being the normal value. CFVR is highly accurate at indicating a good prognosis or the absence of ischemia, particularly if it is obtained early (before DSE completion).^{3, 5-7}

The greatest proportion of myocardial thickening is determined by the contraction of its inner third in the endocardium.⁸ Consequently, an injury with less significant necrosis can determine ventricular wall hypokinesia on echocardiography, even after the ischemic event. However, an expressive contractile reserve is expected after physical or pharmacological stimulation in cases of minor injury. The patient reported here was reperfused within one hour of the AMI onset, which could justify the mild injury and the excellent contractile response during DSE.

The diagnosis of ischemic memory is unusual, but we consider its application adequate for the case presented here, as we have no elements other than previous ischemia to justify these marked ventricular repolarization changes. In fact, some facts substantiate the term ischemic memory in this case: first, the absence of a clinical presentation compatible with coronary insufficiency at rest or even during

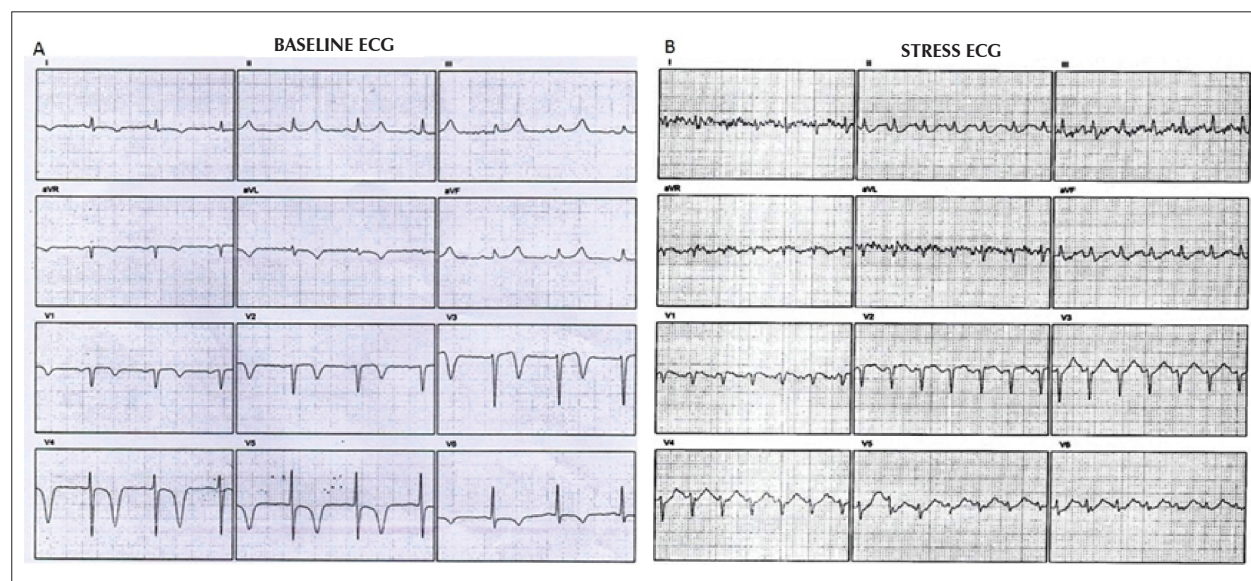
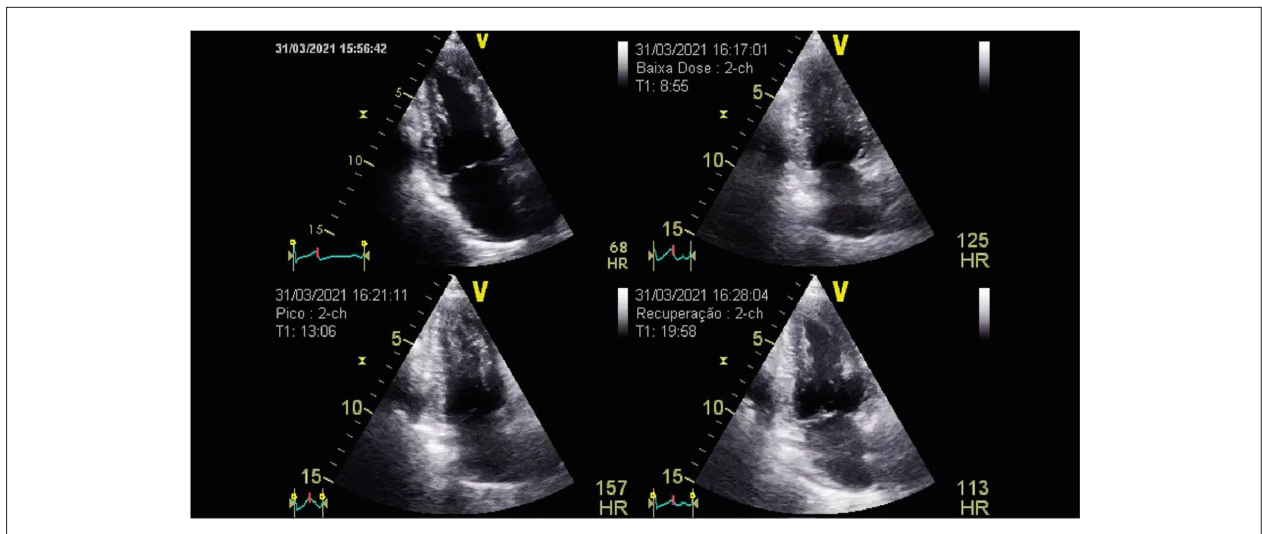
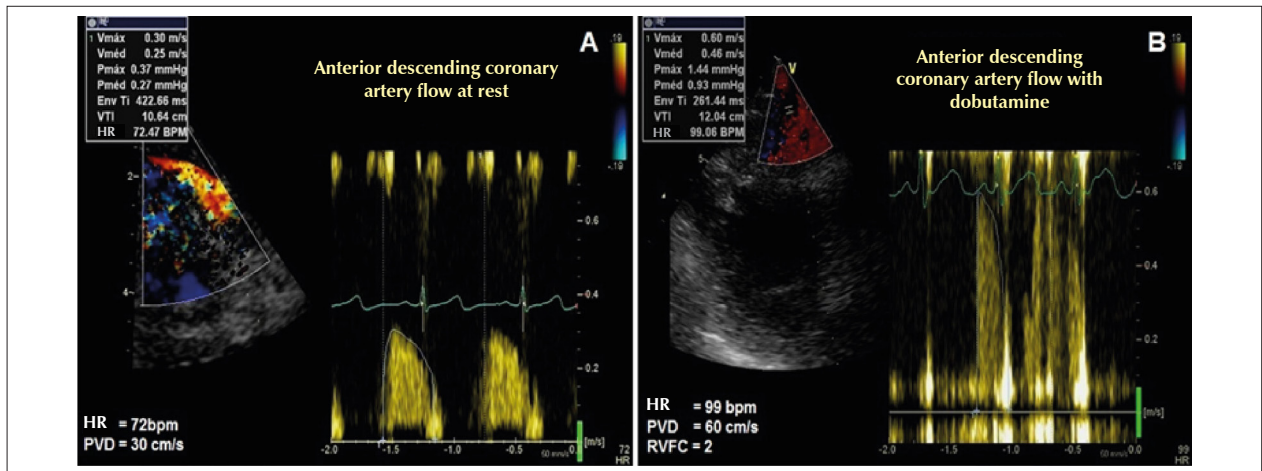


Figure 2 – Electrocardiogram performed 40 days after the acute myocardial infarction showing an anteroseptal inactive zone and deep T wave inversion in the anterior wall (A). T wave polarity is normalized during stress echocardiography (B).



DSE at maximum HR; second, the excellent contractile response of the myocardium during the test; third, the confirmation that the stress ECG showed no ischemia; and fourth, the ADA was patent with good basal flow, showing normal coronary reserve early.

The term “cardiac memory” has been used in cases that show diffuse T wave ECG inversions that may appear after ventricular tachycardia, intermittent left bundle branch block, or Wolff-Parkinson-White syndrome. We initially could not unquestionably rule out the possibility that the patient had previously presented any of these conditions. However, even in the most severe cardiac memory presentations, ECG presents positive or biphasic T wave polarity in the DI lead and positive polarity in the aVL lead.^{9, 10} In this case, the T wave inversion extended to the entire anterior wall, so the possibility of cardiac memory was unlikely.

The exact mechanism of post-infarction ischemic memory is unclear, but it is common to see patients with adequate myocardial reperfusion showing significant ventricular repolarization changes. Considering the isolated ADA disorder, demonstrating its patency in a resting condition corroborates the possibility of DSE assessing the coronary reserve and myocardial contractile reserve, defining the diagnosis and prognosis and avoiding additional tests.¹¹

Conclusion

In the presence of a patent ADA, the demonstration of normal CFVR and myocardial contractility during DSE favor a good prognosis despite the presence of inverted and deep T waves in the anterior wall on ECG in the post-infarction period.

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Authors' contribution

Conception and design of the research: Abreu MEB and Abreu JS; Writing of the manuscript : Abreu MEB and Abreu JS; Analysis and interpretation of the data: Abreu MEB and Abreu JS; Acquisition of data: Pinheiro TCD, Guimarães AAL and Abreu JS; critical review of the manuscript for

important intellectual content: Pinheiro TCD, Guimarães AAL and Abreu JS.

Conflict of interest

The authors have declared that they have no conflict of interest.

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