

# Usefulness of transthoracic color Doppler echocardiography for the identification of left anterior descending coronary artery stenosis

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We briefly describe our experience with transthoracic Doppler echocardiography for the direct evaluation of mid-distal left anterior descending coronary artery (LAD) stenosis. Three patients with previous myocardial infarction, scheduled for coronary flow reserve evaluation, underwent Doppler analysis of the mid-distal LAD. In all 3 cases, the mid-distal LAD stenosis was accurately quantified by the Doppler spectrum as confirmed by quantitative coronary angiography. Our study demonstrated the feasibility of transthoracic Doppler echocardiography in the discrimination of significant and non-significant mid-distal LAD stenosis. Limitations of such a technique could be related to the variable coronary anatomy and to the severity of the atherosclerotic process.

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## Introduction

Recent advances in transthoracic Doppler echocardiography (second harmonic technology, intravenously injected echocontrast agents improving the intensity of the Doppler signal, small transducers that can be angulated intercostally) allowed visualization of the middle-distal tract of the left anterior descending coronary artery (LAD) and its perforating branches as well as the noninvasive measurement of coronary flow reserve during the administration of vasodilators such as dipyridamole or adenosine<sup>1-4</sup>. A coronary flow reserve < 2 assessed in the distal LAD by means of transthoracic Doppler echocardiography has been shown to accurately predict the presence of a significant stenosis (> 70% narrowing) in the proximal LAD<sup>1,4</sup>.

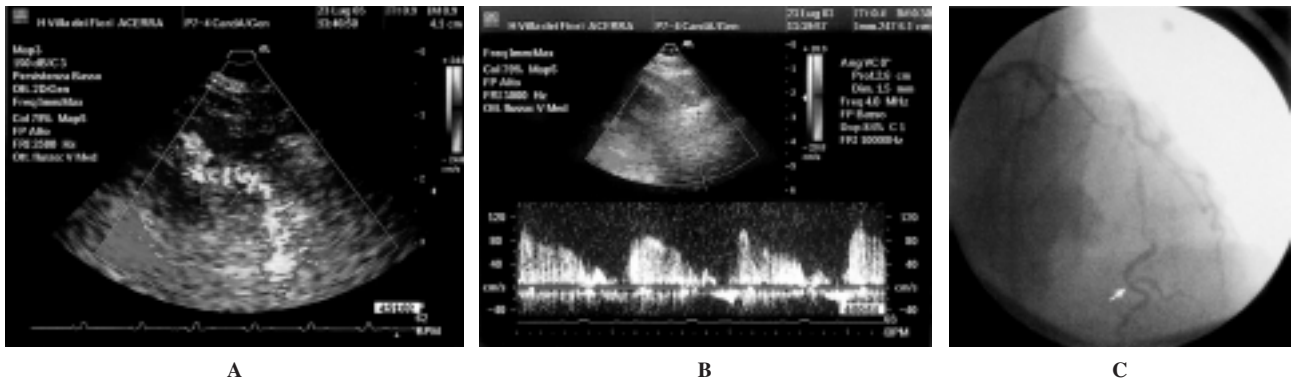
In the present paper, another potential application of transthoracic Doppler echocardiography was described, i.e. the possibility to localize the site and directly quantify the degree of LAD stenosis. Such a technique was validated by comparing Doppler-derived data with the results of a quantitative angiographic analysis (Edix 3-Version II, Manta Medical Division).

## Description of cases

**Case 1.** A 64-year-old male, with previous non-ST-elevation myocardial infarction, came to our observation for stable angina. A high-dose dipyridamole-atropine stress echocardiogram (0.84 mg/kg in 4 min) was performed with simultaneous evaluation of regional wall motion and LAD Doppler flow. We used an ATL HDI 5000 CV with a 2 to 4 MHz and a 4 to 7 MHz transducers, respectively. Color Doppler was used to detect the position of the LAD; the map was programmed with a Nyquist limit of 19-23 cm/s and the color gain was adjusted to obtain adequate images. Velocity measurements were performed with pulsed Doppler using a sample volume of 2 to 4 mm.

Evidence of inducible myocardial ischemia was not found, whereas a kinking of the distal LAD with intermediate anatomic stenosis (50-69% diameter reduction) was diagnosed. The diagnosis was made possible by the Doppler data: presence of aliasing, increased diastolic velocity, mild spectral broadening, and absence of negative frequencies (Figs. 1A, and 1B).

The patient underwent quantitative coronary angiography, that confirmed the pres-



**Figure 1.** Kinking of the distal left anterior descending coronary artery with intermediate anatomic stenosis. A: presence of aliasing at color Doppler; B: increased diastolic velocity, mild spectral broadening, absence of negative frequencies at pulsed Doppler; C: coronary angiography showing the presence of kinkings along the entire mid-distal left anterior descending coronary artery segment.

ence of kinkings along the entire mid-distal LAD segment, with two intermediate stenoses (Fig. 1C).

**Case 2.** A 50-year-old male, with previous anterior myocardial infarction, was referred to our division for chest pain. An echocardiogram showed left ventricular apical akinesis. The patient had a positive response to a high-dose dipyridamole stress echocardiogram, with transient and reversible contractile dysfunction in the LAD territory. Coronary flow in the mid-distal LAD was simultaneously visualized, with Doppler data suggestive of a significant stenosis (> 70% diameter narrowing). We found an increased velocity with predominance of variance effect, marked spectral broadening and turbulence recorded for some centimeters distally from the stenosis as showed by negative frequencies at pulsed Doppler (Figs. 2A and 2B).

The patient underwent coronary angiography exhibiting a proximal LAD occlusion, with counterflow rehabilitation by the right coronary artery which showed multiple severe stenosis along the mid-distal segment (Fig. 2C).

**Case 3.** A 66-year-old male, with a recent uncomplicated inferior myocardial infarction, came to our ob-

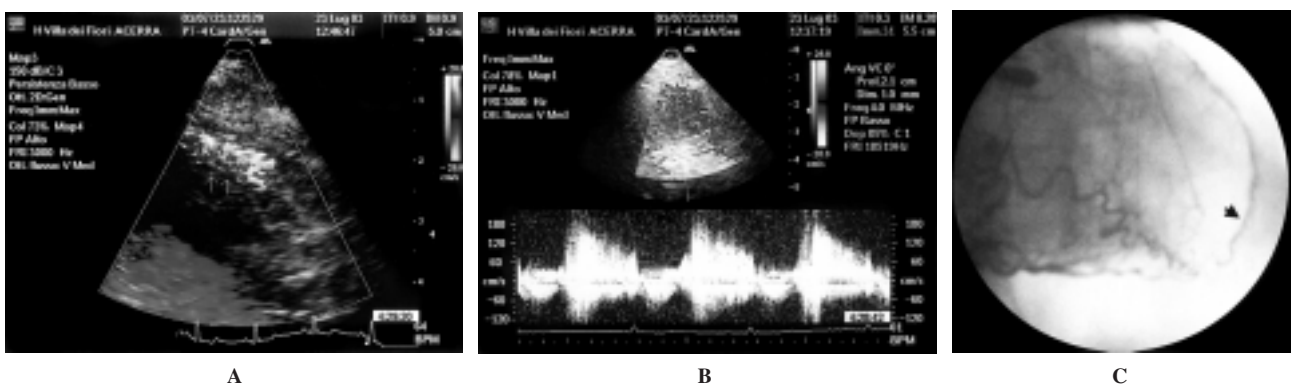
servation during the follow-up without cardiac symptoms. A dipyridamole-atropine stress echocardiogram showed the occurrence of inducible ischemia in the myocardial segments subtended by the left circumflex and LAD coronary arteries. At transthoracic color Doppler echocardiography a significant stenosis of the distal LAD was detected.

The diagnosis was made on the direct and indirect Doppler signs: presence of aliasing and variance effect at color Doppler, increased diastolic velocity (> 200 cm/s), marked spectral broadening, post-stenotic turbulence at pulsed Doppler (Figs. 3A and 3B). Furthermore, a rough noise was heard during Doppler evaluation, which is a trademark of severe stenosis.

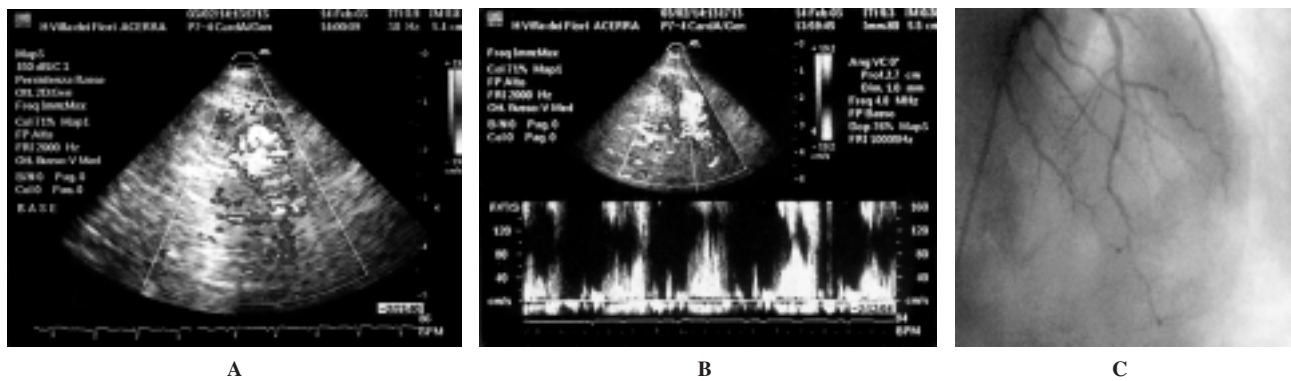
The patient underwent coronary angiography showing a proximal LAD patency but a distal severe stenosis (80%) (Fig. 3C).

## Discussion

Recent studies have shown that assessment of coronary flow reserve by transthoracic color Doppler echocardiography is an accurate and reproducible tech-



**Figure 2.** Significant left anterior descending coronary artery stenosis (> 70% diameter narrowing). A: variance effect at color Doppler; B: marked spectral broadening and negative frequencies at pulsed Doppler; C: coronary angiography exhibiting a proximal left anterior descending coronary artery occlusion, with counterflow rehabilitation by the right coronary artery which showed multiple severe stenosis.



**Figure 3.** A and B: direct and indirect Doppler signs indicative of a significant (> 70% diameter reduction) left anterior descending coronary artery stenosis; C: coronary angiography showing a proximal left anterior descending coronary artery patency but a distal severe stenosis (80%).

nique for the indirect diagnosis of proximal LAD stenosis<sup>1-4</sup>. Furthermore, non-invasive coronary flow reserve has been suggested to represent a useful tool to follow up patients undergoing coronary angioplasty to the LAD<sup>5,6</sup>.

In the present paper, we showed the possibility of directly evaluating by means of transthoracic color Doppler echocardiography the occurrence of hemodynamically non-significant and significant stenosis of the mid-distal LAD. We adopted Doppler criteria for classifying the LAD stenosis, similar to those used for other vascular beds<sup>7</sup>. The Doppler signs were a) the increase of diastolic velocity at pulsed Doppler, b) the presence of variance effect at color Doppler, c) the amount of spectral broadening, and d) the nature of the flow pattern distal to the region of stenosis. The stenosis was evaluated as significant (> 70% of vessel diameter reduction) in the presence of a diastolic velocity > 200 cm/s at the stenosis level and/or with the evidence of a considerable component of negative frequencies some centimeters distally from the stenosis.

In our larger series of patients undergoing Doppler evaluation of the mid-distal LAD (unpublished data), agreement was found between echocardiographic and angiographic data in 13/15 cases.

Limitations of such a technique in the evaluation of site and degree of LAD stenosis could be related to the complex and variable coronary anatomy and to the severity of the atherosclerotic process. For instance, the presence of a big diagonal branch directed towards the apex or, as in the case 2, the occurrence of an occluded LAD rehabilitated by the right coronary artery with evidence of a distal stenosis may lead to a misinterpretation.

It has been demonstrated that well developed collateral vessels produce in a completely occluded coronary artery hemodynamic changes that simulate those of a 90% coronary stenosis without collateral vessels<sup>8</sup>.

Notwithstanding the above-mentioned limitations, in our experience, a diagnosis of intermediate-severe

stenosis of the mid-distal LAD can be accomplished with an accurate Doppler alignment. However, the data presented in this paper should be confirmed in a wider patient population.

## References

1. Hozumi T, Yoshida K, Ogata Y, et al. Noninvasive assessment of significant left anterior descending coronary artery stenosis by coronary flow velocity reserve with transthoracic color-Doppler echocardiography. *Circulation* 1998; 97: 1557-62.
2. Voci P, Testa G, Plaustro G. Imaging of the distal left anterior descending coronary artery by transthoracic color-Doppler echocardiography. *Am J Cardiol* 1998; 81: 74G-78G.
3. Caiati C, Montaldo C, Zedda N, et al. Validation of a new noninvasive method (contrast-enhanced transthoracic second harmonic echo Doppler) for the evaluation of coronary flow reserve. Comparison with intracoronary Doppler flow wire. *J Am Coll Cardiol* 1999; 34: 1193-200.
4. De Simone L, Caso P, Severino S, et al. Reduction of coronary flow reserve non-invasively determined by transthoracic Doppler echocardiography as a predictor of left anterior descending coronary artery stenosis. *Ital Heart J* 2000; 1: 284-94.
5. Pizzuto F, Voci P, Mariano E, Puddu PE, Sardella G, Nigri A. Assessment of flow velocity reserve by transthoracic Doppler echocardiography and venous adenosine infusion before and after left anterior descending coronary artery stenting. *J Am Coll Cardiol* 2001; 38: 155-62.
6. Ruscazio M, Montisci R, Colonna P, et al. Detection of coronary restenosis after coronary angioplasty by contrast-enhanced transthoracic echocardiographic Doppler assessment of coronary flow velocity reserve. *J Am Coll Cardiol* 2002; 40: 896-903.
7. Felix RW, Sigel B, Gibson RJ, et al. Pulsed Doppler ultrasound detection of flow disturbances in atherosclerosis. *J Clin Ultrasound* 1976; 4: 275-82.
8. Flameng W, Schwarz F, Hehrlein FW. Intraoperative evaluation of the functional significance of coronary collateral vessels in patients with coronary artery disease. *Am J Cardiol* 1978; 42: 187-92.