

# Doppler Hemodynamics

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*Your patient is in distress, and all an ECG can tell you is that he has had a previous heart attack. When are 2-dimensional (2-D) echocardiographic and Doppler studies appropriate options, and what special information can they provide? In the case presented, the Doppler recording profiled the hemodynamic status of the patient. Although the 2-D echocardiogram provided valuable information, only the Doppler study is shown to illustrate how sophisticated hemodynamic information can be gathered from Doppler examination. Check your review of the recording with the discussion on the next page. [Rev Cardiovasc Med. 2002;3(1):57–59]*

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**Key words:** Cardiac pressures • Doppler • Flow velocity

The patient is a 62-year-old man who underwent an echocardiographic study to assess cardiac status. An ECG of this patient demonstrated an old anterior myocardial infarction and no other abnormalities. A continuous wave Doppler recording along the left side of the heart acquired from the apical acoustic window is shown in Figure 1.

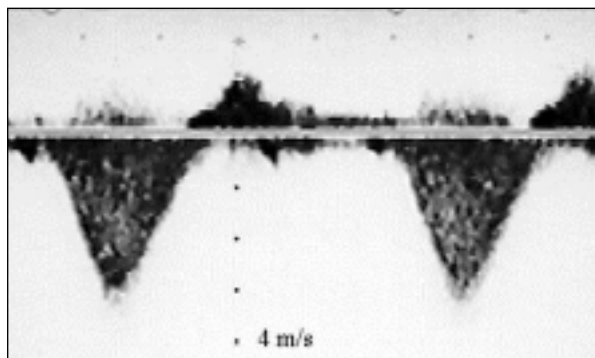


Figure 1.

**Question 1.**

*This recording represents:*

- (a) Mild aortic stenosis
- (b) Severe aortic stenosis
- (c) Subaortic obstruction
- (d) Mild mitral regurgitation
- (e) Severe mitral regurgitation

**Question 2.**

*Based on this recording, the patient's left atrial pressure is:*

- (a) Normal
- (b) Decreased
- (c) Elevated

**Question 3.**

*This patient most likely has:*

- (a) Normal systemic blood pressure
- (b) Hypotension
- (c) Hypertension

**Question 4.**

*Left ventricular contraction in this patient is most likely:*

- (a) Normal
- (b) Diminished
- (c) Hyperdynamic

**Question 5.**

*Based on this tracing, this patient needs:*

- (a) Outpatient therapy with  $\beta$ -blockers
- (b) Emergent therapy

**Discussion**

This patient has had long-standing ischemic cardiomyopathy and was in cardiogenic shock at the time of ECG examination. A 2-D echocardiogram displayed a dilated left ventricle with an ejection fraction of 20%. The correct answers to the questions are severe mitral regurgitation (MR), elevated left atrial (LA) pressure, hypotension, diminished left ventricular (LV) contractile function, and requires emergent therapy. The following discussion describes how this information was derived from the Doppler recording.

**Question 1. This recording represents:**

(e) Severe mitral regurgitation. The continuous wave Doppler examination of the left side of the heart from the apex shows a systolic jet flowing away from the apex. The diagnosis is unlikely to be aortic stenosis or subaortic obstruction, because the flow starts during the isovolumic contraction phase (during the QRS complex on the ECG). Ejection flow jets across the aortic valve will start after the completion of the isovolumic contraction phase. Flow jets related to subaortic obstruction generally start at the beginning of the mechanical systolic phase. Thus, this tracing represents MR. The intensity (amplitude) of the signals is high, indicating that MR is not mild but is more likely to be severe. Furthermore, the early decline in flow velocity in the latter part of systole usually indicates that MR is likely to be severe. High early diastolic mitral flow velocity (exceeding 1 m/s) also suggests increased vol-

ume flowing across the mitral valve secondary to severe MR.

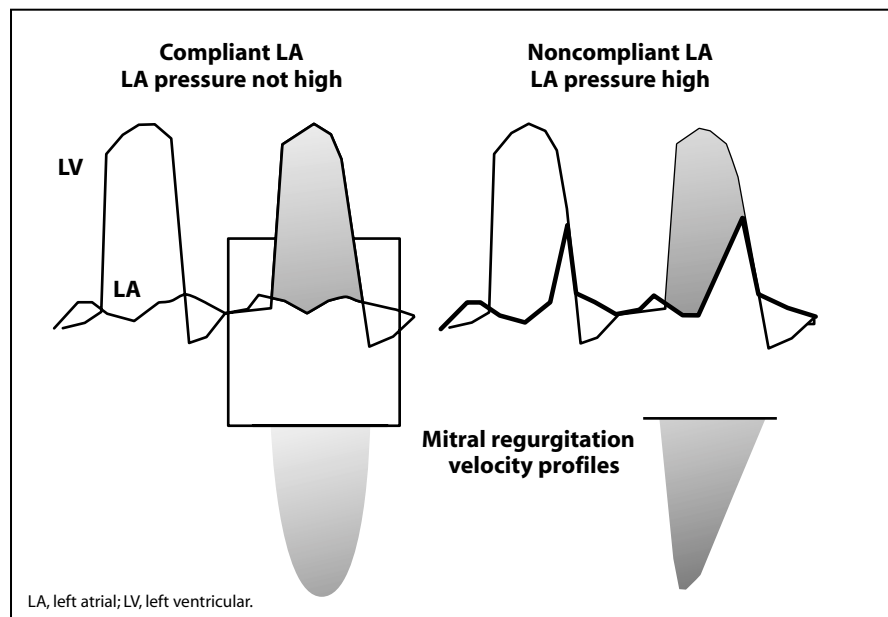
**Question 2. Based on this recording, the patient's left atrial pressure is:**

(c) Elevated. In most cases of MR, the flow velocity rises rapidly in early systole and decreases only during the very last portion of systole. Consequently, in patients with a compliant left atrium and unelevated LA pressure, the mitral flow velocity profile is rounded during most of systole. If LA pressure rises sharply because of either acute or subacute severe MR and the left atrium is relatively noncompliant, the result is a sharp elevation of LA pressure. This, in turn, decreases the gradient between the left ventricle and left atrium; hence, the early decrease in mitral flow velocity (Figure 2).

**Question 3. This patient most likely has:**

(b) Hypotension. Systemic hypotension could be inferred from this

Figure 2.



tracing based on the peak MR velocity, which is much lower than usual. The pressure difference between the left ventricle and left atrium during systole is generally about 80 to 100 mm Hg. Almost always, there is more than 60 mm Hg in a normotensive individual. The MR velocity in this patient is only 3.3 m/s, indicating that the pressure gradient ( $4 \times \text{velocity}^2$ ) between the left ventricle and left atrium is only 44 mm Hg. Even if the LA pressure is 30 mm Hg, the LV systolic pressure is, at most, 74 mm Hg. Thus, the MR flow profile in this patient points to the presence of both hypotension and elevated LA pressure.

**Question 4.** *Left ventricular contraction in this patient is most likely:*  
(b) Diminished. The rate of rise in

MR flow velocity during early systole (the isovolumic contraction phase) reflects the rate of rise in LV systolic pressure—ie, positive  $dp/dt$ . In a normally functioning left ventricle, the MR flow velocity accelerates rapidly, while in this patient, there is very slow acceleration secondary to markedly impaired LV contractile function (Figure 3). It should be noted, however, that in patients with left bundle branch block, the rate of rise in MR velocity could be slow. In addition, lack of appreciable abnormality in acceleration does not exclude LV dysfunction.

**Question 5.** *Based on this tracing, this patient needs:*

(b) Emergent therapy. A patient in this hemodynamic situation of

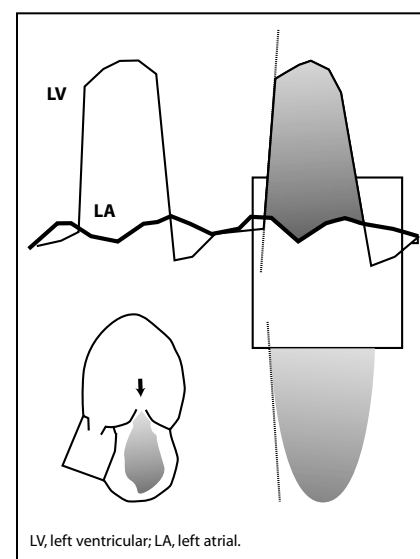


Figure 3.

cardiogenic shock requires emergent therapy. ■

### Main Points

- The intensity of Doppler signals can help determine the degree of severity of mitral regurgitation.
- The mitral regurgitation velocity profile is indicative of the pressure gradient between the left ventricle and right atrium.
- The rate of rise in mitral flow velocity during early systole reflects the rate of rise in left ventricular systolic pressure.