

Time overlap of mitral and aortic regurgitations in a patient with systolic heart failure

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A 44-year-old man with postinfarction heart failure (HF) and New York Heart Association functional class III underwent routine transthoracic echocardiography (TTE), which demonstrated dilatation of all cardiac chambers, left ventricular (LV) systolic dysfunction with an ejection fraction of 20%, grade III diastolic dysfunction of the LV with E/A of 2 and E/E' of 19, severe mitral regurgitation (MR), and moderate aortic regurgitation (AR) (FIGURE 1). Twelve-lead electrocardiography showed sinus rhythm at 78 bpm, a PQ interval of 150 ms, and a QRS complex of 150 ms due to nonspecific abnormalities of intraventricular conduction.

Electrocardiography-gated TTE images visualized concurrent severe MR and moderate AR. Mitral regurgitation persisted during the whole systole and early diastole, whereas AR during the entire diastole and early systole (FIGURE 1A, 1D, and 1E). Both regurgitation jets overlapped for more than 70 ms during systole (FIGURE 1A and 1B) and more than 90 ms during diastole (FIGURE 1A and 1C).

Aortic regurgitation is presumed to end with diastole, while MR, with systole.¹⁻³ However, in patients with severe systolic HF, MR and AR may exceed the duration of their respective time intervals.^{4,5} The pathophysiology of diastolic MR and systolic AR in our patient with systolic HF was affected by the mechanical properties and structural changes of the LV, with marked, mutual influence of both regurgitant waves during isovolumetric relaxation and contraction. During isovolumetric relaxation, LV pressure, although rapidly declining, is still higher than left atrial pressure. An insufficient increase in the pressure gradient across the mitral valve to overcome MR in early diastole results from increased LV filling pressure due to severe LV

diastolic dysfunction. The asynchrony of LV contraction with postsystolic shortening of LV segments and accompanying moderate AR additionally contribute to high LV diastolic pressure. The dilatation and impaired contractility of the LV cause increased tethering of the mitral leaflets, as well as changes of the valve geometry and its incomplete closure during early diastole, which enables diastolic MR. On the other hand, severely reduced LV contractility with asynchrony and severe MR delay opening of the aortic valve (LV pressure built during isovolumetric contraction is unable to exceed the pre-ejection aortic pressure) and thus AR is still present early during systole.

There are several consequences of overlapping AR and MR. First, there is a mismatch between the electric, hemodynamic, and echocardiographic systole and diastole. Electric depolarization and myocardial contraction start when LV filling is still ongoing. On TTE, the mitral valve is already closed, but the LV size still increases. Therefore, it is challenging to assess which echocardiographic frame should be considered for the end-diastolic and end-systolic measurements of the LV wall thickness and diameter. In addition to these methodological problems, the impairment of both isovolumetric contraction and relaxation times along with the shortening of LV ejection (FIGURE 1A and 1E) result in further worsening of LV and atrial hemodynamics.

ARTICLE INFORMATION

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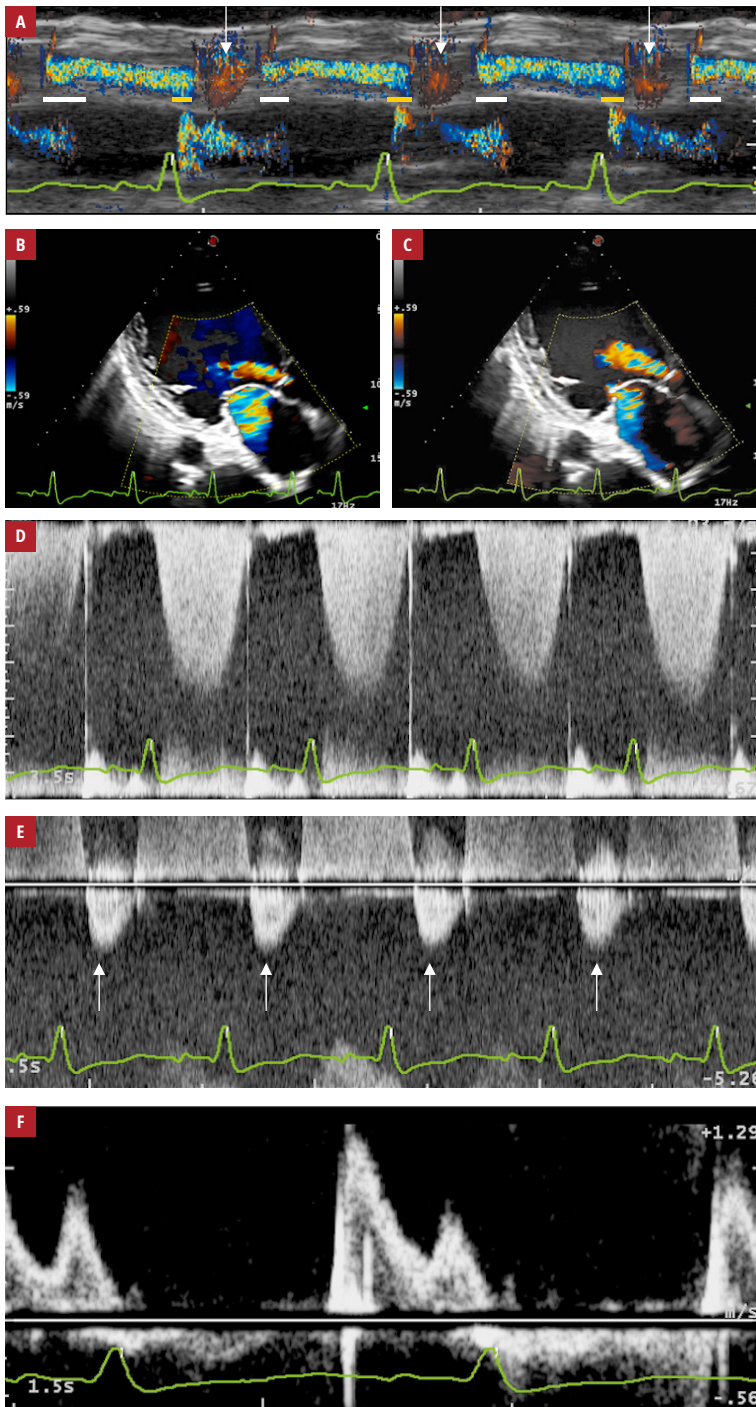


FIGURE 1 Electrocardiography-gated color Doppler M-mode (A), 2-dimensional mode (B and C), continuous-wave Doppler across the mitral wave (D), pulse-wave Doppler of the left ventricular outflow tract (E), and pulse-wave Doppler of mitral inflow (F) images acquired from a 44-year-old man with postinfarction severe systolic heart failure, severe mitral regurgitation, and moderate aortic regurgitation. The images show concurrent mitral and aortic regurgitation jets during systole lasting longer than 70 ms (yellow horizontal bars on A and B) and during diastole for more than 90 ms (white horizontal bars on A and C). Mitral regurgitation persisted for the whole systole and early diastole (A, C, and D). In contrast, aortic regurgitation lasted for the entire diastole and early systole (A, B, and E). The time overlap of both regurgitation jets was accompanied by the shortening of left ventricular ejection (arrows on A and E) and LV diastolic dysfunction grade III (F).

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