M-mode imaging depicts temporal changes along a single axis by plotting the depth of penetration on the y axis and the time of acquisition on the x axis. In color M-mode, the standard tissue delineation and the color Doppler signal are superimposed, thereby, demonstrating a large amount of information in an illustrative fashion, using only a single echocardiographic still frame. However, in clinical practice, color M-mode is infrequently performed and not generally recommended in a standard echocardiography study. In the last few years, ventricular assist devices (VADs) have become a widely used treatment in advanced heart failure. In principle, VADs support the terminally failing heart by partially or completely taking over ventricular function with a mechanical pump, either using pulsatile or continuous flow. Depending on the level of impairment, they support the left (left ventricular assist device) or both ventricles (biventricular assist device [BiVAD]). In patients with a VAD, color M-mode has been recommended as a supplemental echocardiographic measurement. Nevertheless, also in patients with VADs, color M-mode is rarely used in daily routine.

Case Report
In a 65-year-old male with advanced ischemic heart disease, a BiVAD with pulsatile flow was implanted 25 months ago (Berlin Heart, Excor). He is scheduled for routine echocardiography. A color M-mode through the aortic valve acquired from an apical long-axis axis is depicted; the small embedded picture illustrates the view of M-mode acquisition (Figure). This single still frame provides an impressive amount of information regarding this patient’s hemodynamic state:

1. In the left ventricular cavity, a diastolic flow toward the probe—representing the mitral inflow—is visible. It is driven by the relaxation of the left ventricle, strictly coinciding with the diastole of the ECG. However, duration and velocity of the signal depend considerably on the temporal relation to the BiVAD cycle, with higher velocities during the BiVAD suction phase.
2. The continuous signal in the left ventricular outflow tract represents mild systolic–diastolic aortic regurgitation. This finding indicates a higher pressure in the aorta than in the left ventricle throughout the heart cycle, caused by the competing BiVAD flow in the ascending aorta. Accordingly, the aortic valve remains in a closed position during both diastole and systole (as depicted in the M-mode), representing an important complication in VAD patients.
3. In the ascending aorta, a strictly periodic but ECG-independent signal represents the ejection phase of the BiVAD, pumping blood from the left ventricle into the ascending aorta with a rate of 60 cycles per minute.
4. A simultaneous limb lead ECG reveals a sinus rhythm with 98 beats per minute and a wide QRS complex.

Discussion
The growing number of patients receiving VADs will increase the need for thorough echocardiographic assessment in these patients. This case illustrates the remarkable potential of color M-mode to comprehensively assess VAD function and associated complications.

Disclosures
None.

References

Key Words: echocardiography ■ heart failure ■ heart ventricles ■ heart-assist devices ■ ventricular function
Figure. Color M-mode from an apical view through the aortic valve in a 65-year-old male with advanced ischemic heart failure and a biventricular assist device (BiVAD; Berlin Heart, Excor). The small embedded picture illustrates the axis of M-mode acquisition.
Comprehensive Hemodynamic Assessment in a Single Echocardiography Still Frame
David Niederseer, Michelle Frank, Felix C. Tanner and Simon F. Stämpfli

Circ Heart Fail. 2016;9:
doi: 10.1161/CIRCHEARTFAILURE.116.003374
Circulation: Heart Failure is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2016 American Heart Association, Inc. All rights reserved.
Print ISSN: 1941-3289. Online ISSN: 1941-3297

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circheartfailure.ahajournals.org/content/9/8/e003374

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation: Heart Failure can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation: Heart Failure is online at:
http://circheartfailure.ahajournals.org//subscriptions/