Cardiac Auto Doppler

Uwe Lempertz, Ella Sokulin
GE Healthcare

Introduction

Echocardiography traditionally has been all about the image. Due to its non-invasive nature and ubiquitous availability, echocardiography has become one of the leading diagnostic imaging techniques.

While 2D echocardiographic imaging provides anatomical display of the cardiovascular anatomy with high temporal resolution, Doppler techniques are invaluable for the hemodynamic evaluation of the heart and assessing valvular function. However, in order to help make appropriate treatment decisions, the quantitative evaluation of Doppler acquisitions should be accurate and reproducible. Precise measurements are time-consuming to perform and can vary with the skill level of the operator. Thus, a tool that produces accurate and reproducible results quickly might have the potential to accelerate the workflow in routine echocardiographic studies.

GE Healthcare has introduced many breakthrough quantitative ultrasound tools based on leading-edge technologies, such as Anatomical M-Mode, Tissue Velocity Imaging (TVI), Automated Functional Imaging (AFI) and AutoEF to help sonographers and echocardiographers meet the increasing demand for productivity and quality. The addition of Cardiac Auto Doppler to the toolset of our Vivid™ E90/95, Vivid S60N/70N and Vivid *iq* scanners, as well as EchoPAC,™ is a natural next step.

Method

The Cardiac Auto Doppler feature utilizes several advanced signal and image processing algorithms.

They are based on an adaptive algorithm that automatically detects envelopes and peaks and includes a control to quickly adjust the sensitivity according to the user's preferences.

The algorithm is based on raw data processing, thus it is independent from display settings like gain, compress, reject or color maps. A key advantage of raw data processing is the utilization of all Doppler vectors (full sampling rate) of the acquisition rather than basing the processing on DICOM images, which are limited to the resolution of the image shown. Raw data processing provides robust and reproducible results.

Cardiac Auto Doppler workflow description

After opening the appropriate measurement folder there are two possibilities to proceed. Either do the conventional manual assessment or select the "Auto" button where available. The tool offers the 7 most commonly used parameters:

- LVOT Vmax
- LVOT Trace
- AV Vmax
- AV Trace
- TR Vmax
- MV E/A Velocity
- É, Élateral, Éseptal

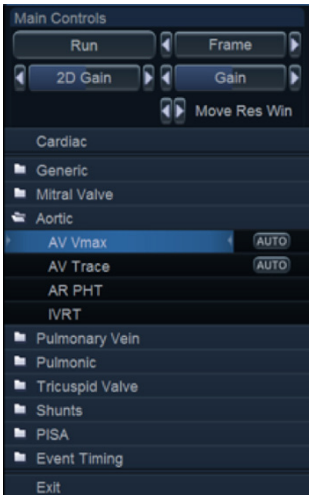

Figure 1

In figure 1, the user would select **Auto** for AV Vmax. The system detects the peaks for all full cycles that are displayed on the screen and displays the averaged result of this measurement.

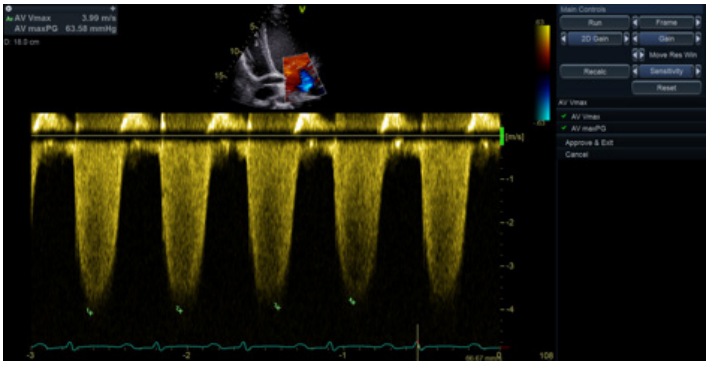

Figure 2

In the control section (the rotary on scanners), a **sensitivity** control is available for easy and fast adjustments if needed.

In case an outlier may be present, it can easily be excluded from the calculation by simply clicking on the **red cross** that appears when hovering the pointer into the area of the heart cycle. When clicking on the **green check mark**, only this cycle will be selected for the analysis. By check marking several cycles, the average of those will be presented in the results box.

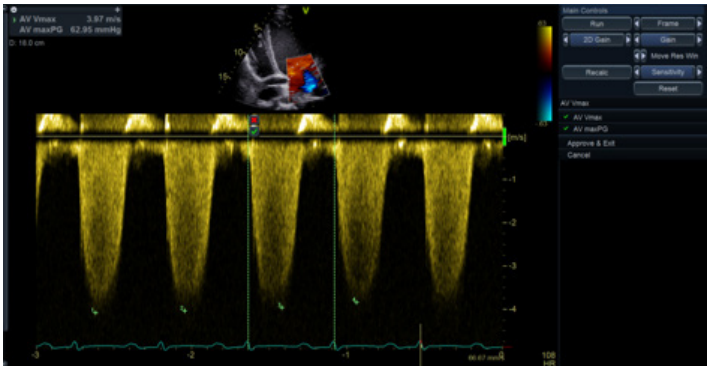

Figure 3

All measurements from the selected cycles are transferred into the Worksheet to be used for reporting when selecting the **Approve & Exit** stage.

The next example shows auto detection of AV tracing.

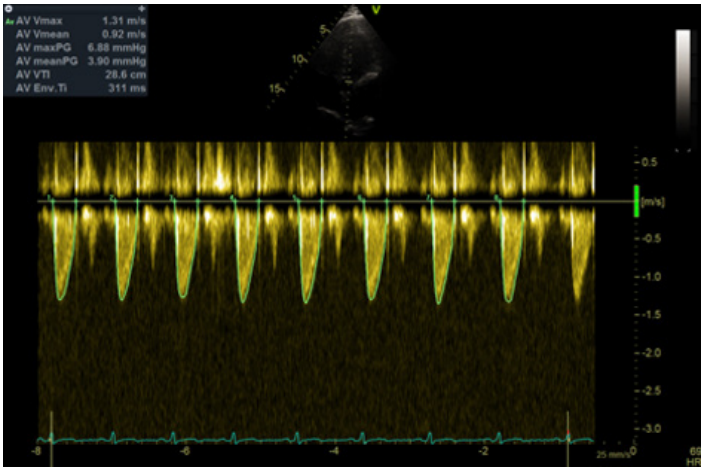

Figure 4

Validation

A wide variety of Doppler acquisitions, including normal and pathologic flow patterns for AV, MV, LVOT, TR and E', were analyzed by 10 independent experienced operators. The absolute results for their manual measurements and the automatic measurements, as well as the time used for each method, were recorded. The data were analyzed comparing the accuracy, the inter-observer variability and the time needed for the two methods.

Accuracy and inter-observer variability:
The variability between the experienced operators' results for the manual measurements is on average more than three times higher than the bias between the automatic measurement and the average of all manual measurements.

Time saving:
The time needed to measure was reduced from 2 - 16 s (dependent on the parameter) for the manual measurements to less than 1 s for all automatic measurements. See the details in the table.

	Manual per heart cycle, sec	Auto Doppler per heart cycle, sec
LVOT Trace	12-16	<1
AV Trace	12-16	<1
MV, E/A	5-8	<1
E'	2-4	<1
TR, Vmax	2-4	<1

Conclusion

GE Healthcare's Cardiac Auto Doppler tool has proven to be fast, consistent and reproducible, and thus may help address the need of busy routine echocardiography services to provide accurate and reproducible results quickly. It reduces the operator's time up to 15 seconds per measurement compared to manual interaction. Moreover, the utilization of the tool consistently reduces the inter-observer variability.

GE Healthcare's Cardiac Auto Doppler tool might be a valuable asset in the armamentarium of sonographers and echocardiographers, meeting their needs for improved productivity.

Imagination at work

JB49055XX