AutoEF using a2DQ$^{\text{A.I.}}$ featuring **Anatomical Intelligence**

Philips EPIQ 7 **ultrasound system**

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A computerized approach, Automated 2D Cardiac Quantification$^{\text{A.I.}}$ (a2DQ) with Anatomical Intelligence has the potential to reduce both the time to complete measurements of cardiac volume and ejection fraction and the variability of those measurements. The performance of a2DQ$^{\text{A.I.}}$ was evaluated by comparing its results to expert hand-tracings for 53 sets of images of various heart sizes and function acquired using the Philips EPIQ 7 ultrasound system.

Background

Assessment of cardiac volume and ejection fraction is integral to cardiac diagnosis and patient management. Unfortunately the measurement of cardiac volumes using ultrasound has a number of significant issues that make its routine use a challenge. Hand-tracing multiple images is time-consuming, subject to significant variation, and dependent on the skill and knowledge of the person doing the tracing.

Anatomical Intelligence

Anatomical Intelligence is a computerized approach using machine intelligence to automate the measuring of cardiac volumes. The user acquires an image of the left ventricle in an orientation suitable for quantification. A Region of Interest (ROI) is automatically established using anatomical landmarks and a database of anatomical models.

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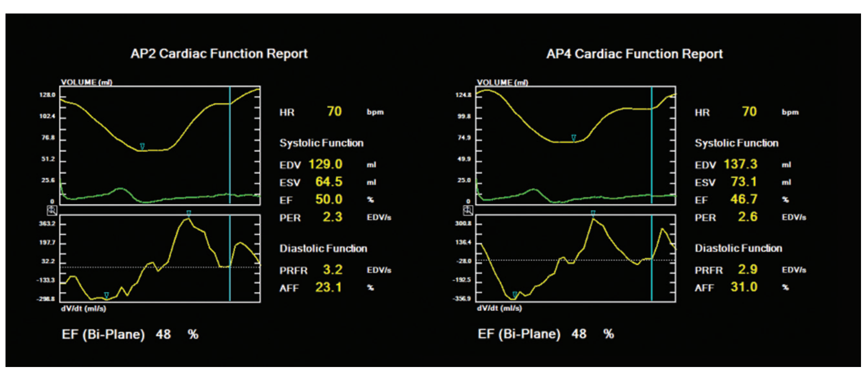
This ROI serves to approximate the position of the endocardial boundary. The precise position of the boundary of the endocardium is found by locating the interface between the low-level signal from the blood pool and the high-level signal from the myocardium. Considerable variation can result from this last step, depending on the quality of the ultrasound images. Combining "model fitting" information on how the left ventricle is shaped with anatomical information from the image improves the positioning of the endocardial boundary, especially for images of low quality.

Once the endocardial border has been detected on one frame, it is tracked throughout the cardiac cycle using speckle tracking. Tracking the border from frame to frame is more robust than individually finding the endocardial border in each frame, because information from multiple frames can be used.

The volume for each frame is calculated using Simpson's Method of Disks to produce a volume curve. From the volume curve the maximum and minimum volumes are used to calculate the ejection fraction (EF). A great deal of information can be gleaned from the volume waveforms beyond simply the volumes at ED and ES and the EF. Measures such as ejection time, early filling fraction, and atrial filling fraction provide additional information that has been shown to have significant clinical utility.

In some cases, the user may not agree with the automatically generated endocardial border and wish to edit it. This may be due to unusual shapes that the automatic approach has difficulty handling or to situations in which the image quality is so poor that the endocardial boundary is not clearly visualized. When the image quality is poor, a user observing the dynamic heart motion may be able to discern the endocardial boundary location better than the static automatic detection technique.

After the boundary has been edited in one frame, the speckle technique will track the boundary in frames before and after the edit frame. This saves the user the time and effort to trace these additional frames.



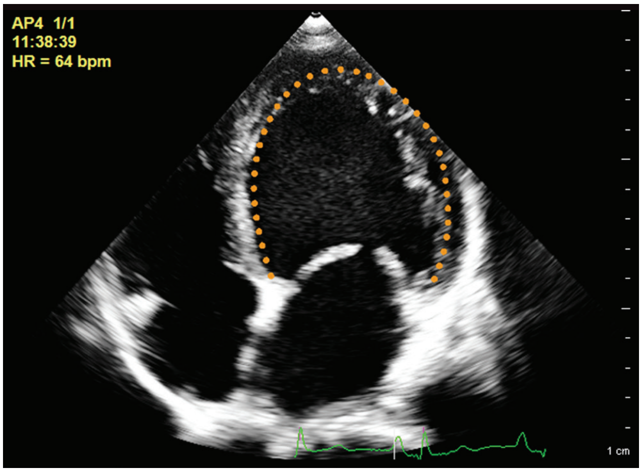


Image with good tracking.

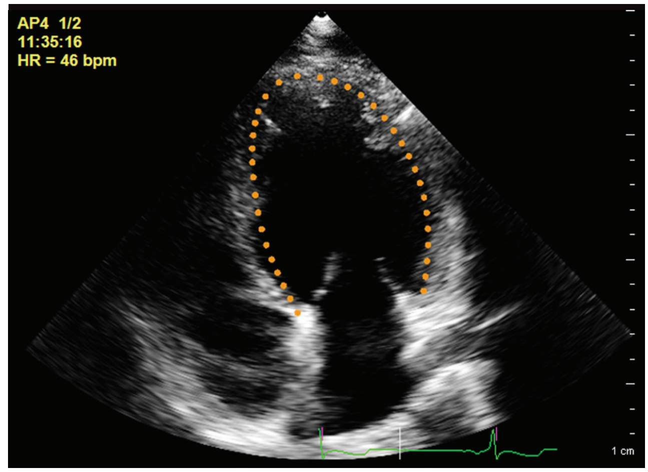
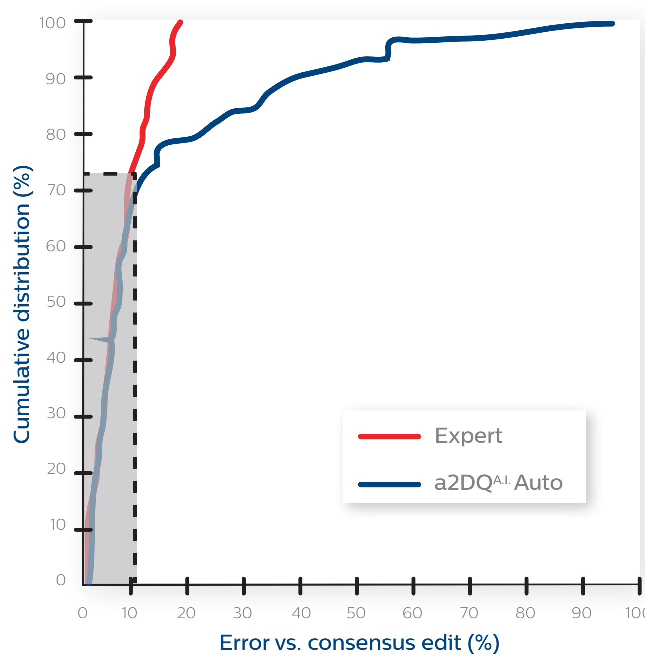


Image with poor tracking.

Validation

The performance of a2DQ[A.I.] was evaluated by comparing its results to expert hand-tracings for 53 sets of images of various heart sizes and function acquired using the Philips EPIQ 7 ultrasound system. It is important to note that expert tracings of the endocardial border are estimates and as such are subject to variability. To reduce this variability, each of the hand-tracings were done twice by two different experts. The resultant four volume measurements were then averaged to create a consensus average.

The following chart compares this consensus average to the automatic a2DQ[A.I.] results. Included in the chart is a comparison of the consensus average to the results from one of the expert tracers.



Conclusion

In this study, a2DQ[A.I.] successfully matched the performance of the expert user in approximately 70% of the cases. The expert user, however, was better for images of very low image quality or very unusual shapes.

Please visit **www.philips.com/anatomicalintelligence**

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