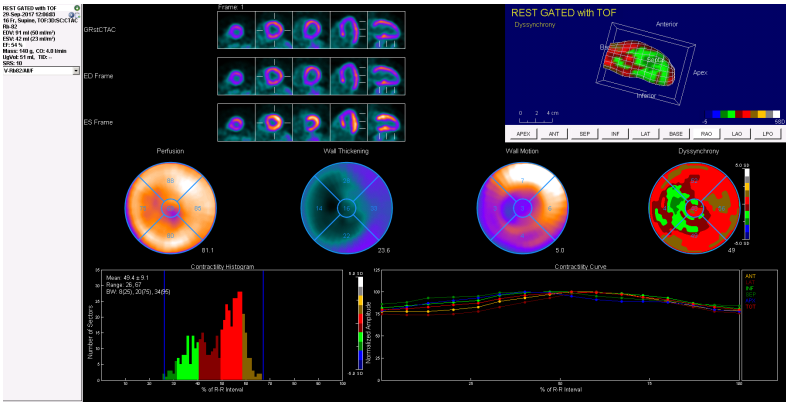
Dyssnchrony Workflow Screen

OVERVIEW

Left ventricular (LV) dyssynchrony occurs when one or more regions of the ventricular myocardium contracts significantly later than other regions, resulting in reduced cardiac efficiency, and decreased cardiac output and ejection fraction. Dyssynchronous wall motion affects how efficiently the LV can pump blood to the rest of the body. Evaluation of both global measures of dyssynchrony as well as regional contraction patterns of the left ventricle, is believed to be of use in identifying which patients with heart failure may benefit from cardiac resynchronization therapy (CRT). Quantification of dyssynchrony can also assist in evaluating the effectiveness of CRT post procedure.

The Dyssynchrony workflow screen within Corridor4DM (4DM) focuses on the left ventricle contraction phases. There are two main purposes for reviewing the data on this screen; to evaluate patients with known or newly diagnosed congestive heart failure (e.g., LVEF <35%) to improve cardiac function, patient symptoms, and prognosis. The 4DM workflow can assist in identifying the regions of LV walls that are not contracting in-sync with the other walls of the LV and potentially help with planning pacemaker lead placement for CRT.

Dyssynchrony review is part of 4DM's standard SPECT, PET and GBPS workflows and does not require extra imaging or steps to access. Quantification data is generated for standard gated MPI studies -- no extra processing or visual quality assurance checks by the technologist or physician is needed. It is recommended that relatively narrow EKG R to R' acceptance windows be employed during image acquisition for the best results. Simply activate the screen in 4DM to review Dyssynchrony results for both current and retroactive patient studies.



CHOICE OF ALGORITHM

4DM provides multiple algorithms for estimating regional LV dyssynchrony. The choice of algorithm depends on the imaging protocol and the clinical need. The available algorithms are defined as follows.

Algorithm	Description	Recommended Use
Time to Peak Thickening-1 (TPT-1)	Using the change in LV tissue intensity during the cardiac cycle, the time to peak contraction (thickening) is determined using a single harmonic fit.	This is the preferred algorithm for gated perfusion studies. This algorithm is analogous to ECTb's Phase Analysis.
Time to Peak Thickening (TPT)	This is based on the same principles as TPT-1, but it uses multiple harmonics to fit the data.	Primarily research. This option has not been used extensively for clinical use.
Time to Peak Contraction (TPC)	Using the regional changes in chamber volumes as defined the by the endocardial surface, the regional time to peak contraction is determined.	This is the preferred algorithm for gated blood pool studies. This algorithm is analogous to the method used in echocardiography but the temporal resolution for nuclear is not as favorable as echo.

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HOW-TO GUIDE

To accurately assess patients for dyssynchrony, the user will review the following image displays and numerical data to identify any abnormalities in contractile function.

- *Evaluate Contractility Curves*
- *Evaluate Contractility Histogram*
- *Interpreting the Numbers*

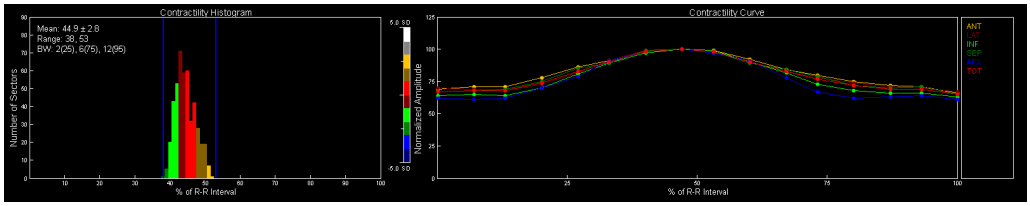
The Contractility Curves:

The display of Contractility Curves is a simple visual that shows the user whether any walls of the left ventricle are not contracting as well as others. This information is also displayed in the 2D and 3D Dyssynchrony polar maps. The other polar maps on the screen are presented so the user can correlate the dyssynchrony information with perfusion, wall motion, and wall thickening maps.

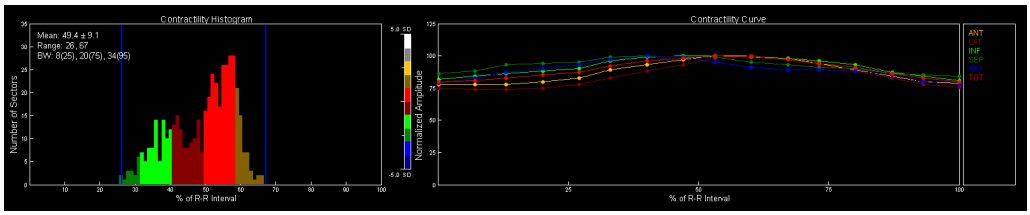
This display is useful in identifying which walls of the LV are contracting out of sync with the others. When each of the LV walls have their peaks (TPT) or valleys (TPC) well aligned, the walls of the LV are contracting in-sync (see Figure 1, patient 1); When the LV walls are contracting out-of-sync the LV wall curves are not aligned and do not peak at the same point. (See figure 1, patient 2.)

Figure 1. Contractility Curves

Patient #1 - Normal



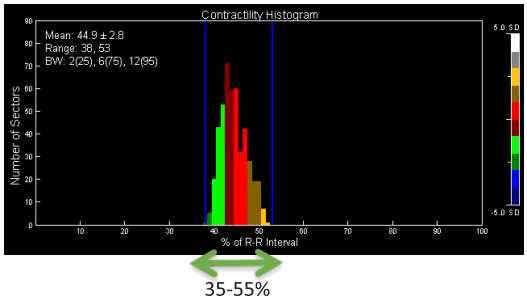
Patient #2 - Abnormal



The Contractility Histogram:

The Contractility Histogram plots the time to peak contraction in a percentage display of the R-R frame. Time-to-Peak represents the mean point where the primary contraction occurs, expressed as a percentage of the cardiac cycle. In normal contraction patterns, there is one primary peak, which typically occurs between the 35-55% point of the cardiac cycle, making the peak contraction around the mid-point of the heartbeat.

Histograms with a sharp peak and narrow distribution represent a heart where regions are contracting at the same time or synchronously signs of a healthy, efficient heart. Histograms with a wide distribution are indicative of a ventricle where regions are delayed in contracting and is dyssynchronous with likely reduced cardiac efficiency, and decreased cardiac output and ejection fraction.



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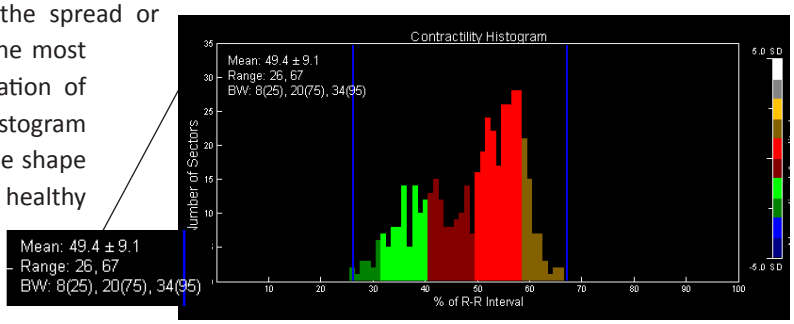
Interpreting the Results:

The width of the histogram provides a measure of the spread or difference in the time when regions are contracting. The most useful measure of dyssynchrony is the standard deviation of the contractility histogram which is a measure of the histogram width assuming the distribution is a single peak with the shape of a bell (i.e. normal statistical distribution). From a healthy cardiac population, the normal values for histogram standard deviation and a threshold for determining abnormal (95% confidence) are tabulated below.



Algorithm	Standard Deviation	Abnormal Threshold (95% confidence)
TPT-1	2.8 +/- 0.9	5.5
TPC	3.2 +/- 1.1	6.3

Of particular note is that when the curve has multiple peaks or it is very wide, the standard deviation value may not be an accurate measure of true spread in timings because the distribution does not follow a normal statistical model. In this case, the 95% BW values can be used. When the 95% BW value is much greater than 2 times the standard deviation, the distribution is not normal and is indicative of even greater dyssynchrony.