The promise of a healthy heart.

TED ROGERS CENTRE
FOR HEART RESEARCH

Partners in the Ted Rogers Centre for Heart Research

SickKids UHN Toronto General Toronto Western Princess Margaret Toronto Rehab UNIVERSITY OF TORONTO

Strain Image Selection Examples

Strain Image Selection

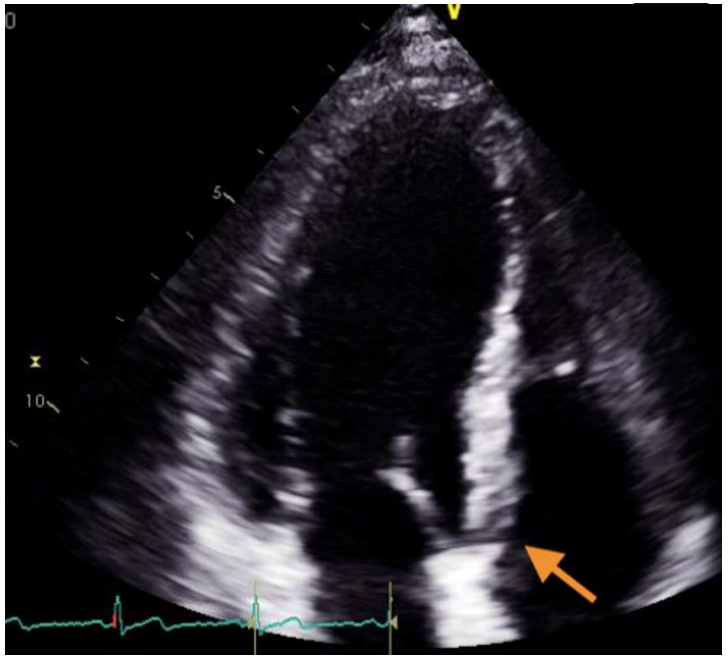
- In order to accurately measure global longitudinal strain (GLS), it is important to select optimal images of the apical 3, 4 and 2 chamber views. This includes:
- Consistent heart rate and frame rate between the three apical views
- Proper and clean ECG signal to achieve optimal tracking of the myocardium
- Inclusion of the mitral valve (MV) and aortic valve (AoV)
- Inclusion of the entire ventricle throughout the duration of the cardiac cycle

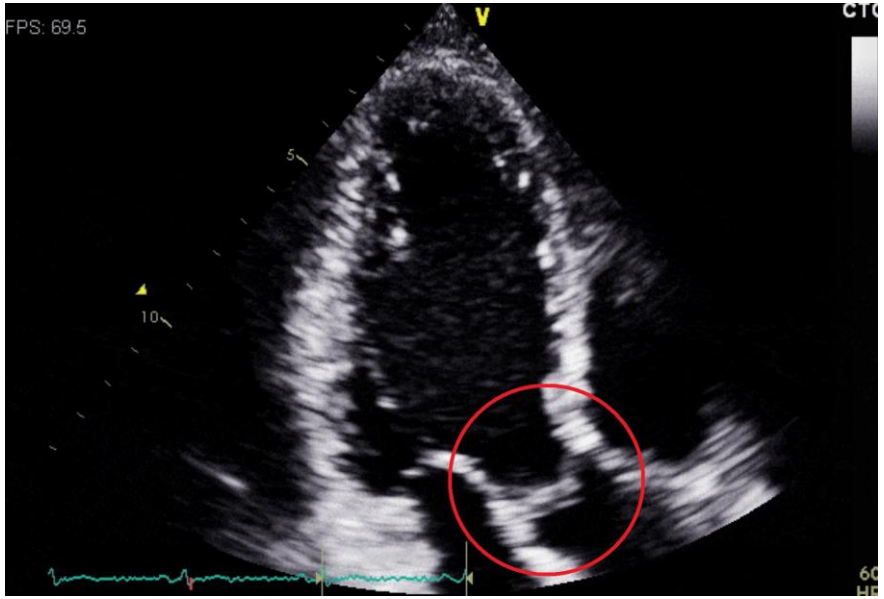
Heart Rate:

- Select the three apical views sequentially together in time to avoid variability in the heart rate.
- Strain analysis can be challenging in patients with significant heart rate variations or arrhythmias.
  - To avoid this challenge, select the cardiac cycle without arrhythmias.

Electrocardiogram (ECG):

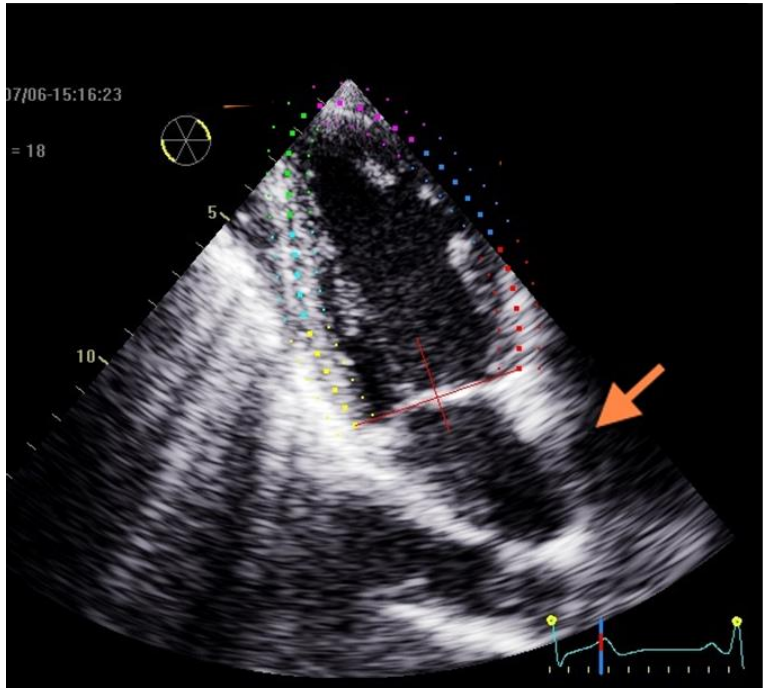
- Select an image which displays proper ECG signal gating and three consecutive beats.
- Select an image that shows an open aortic valve to measure aortic valve closure (AVC) timing.

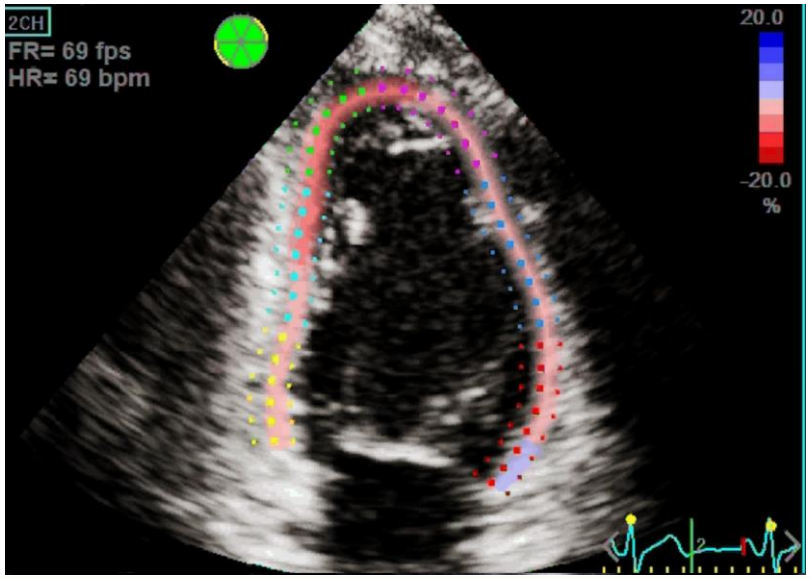




Depth:

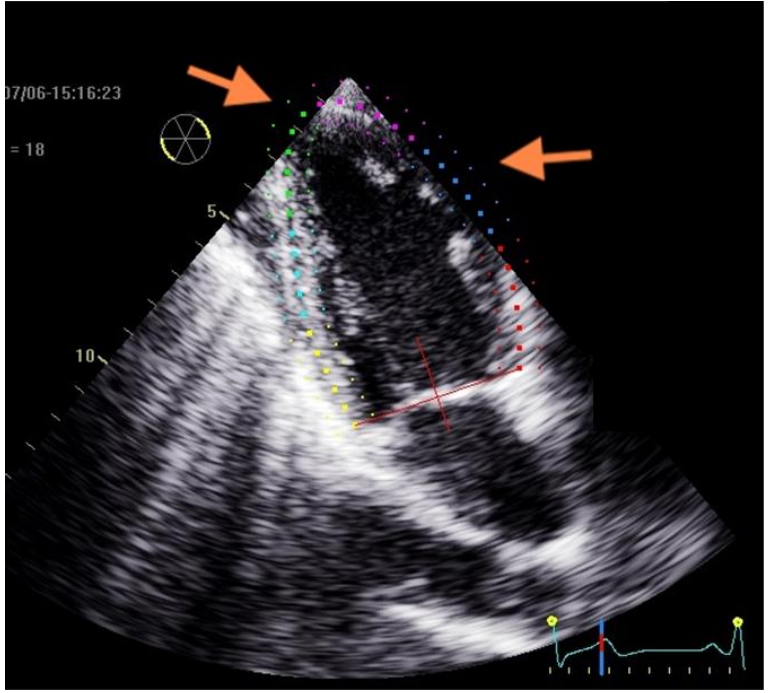
- Select an image that was acquired with appropriate depth showing part of the atrium and the entire ventricle.

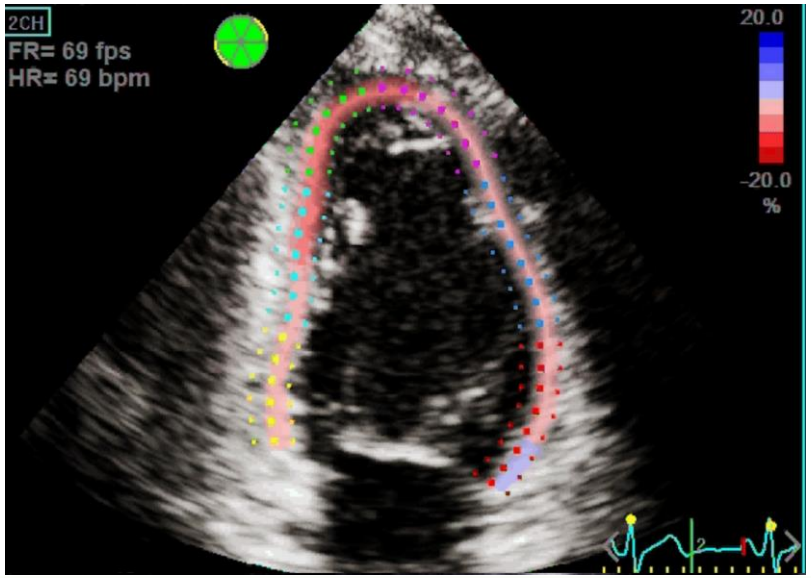




Sector Width:

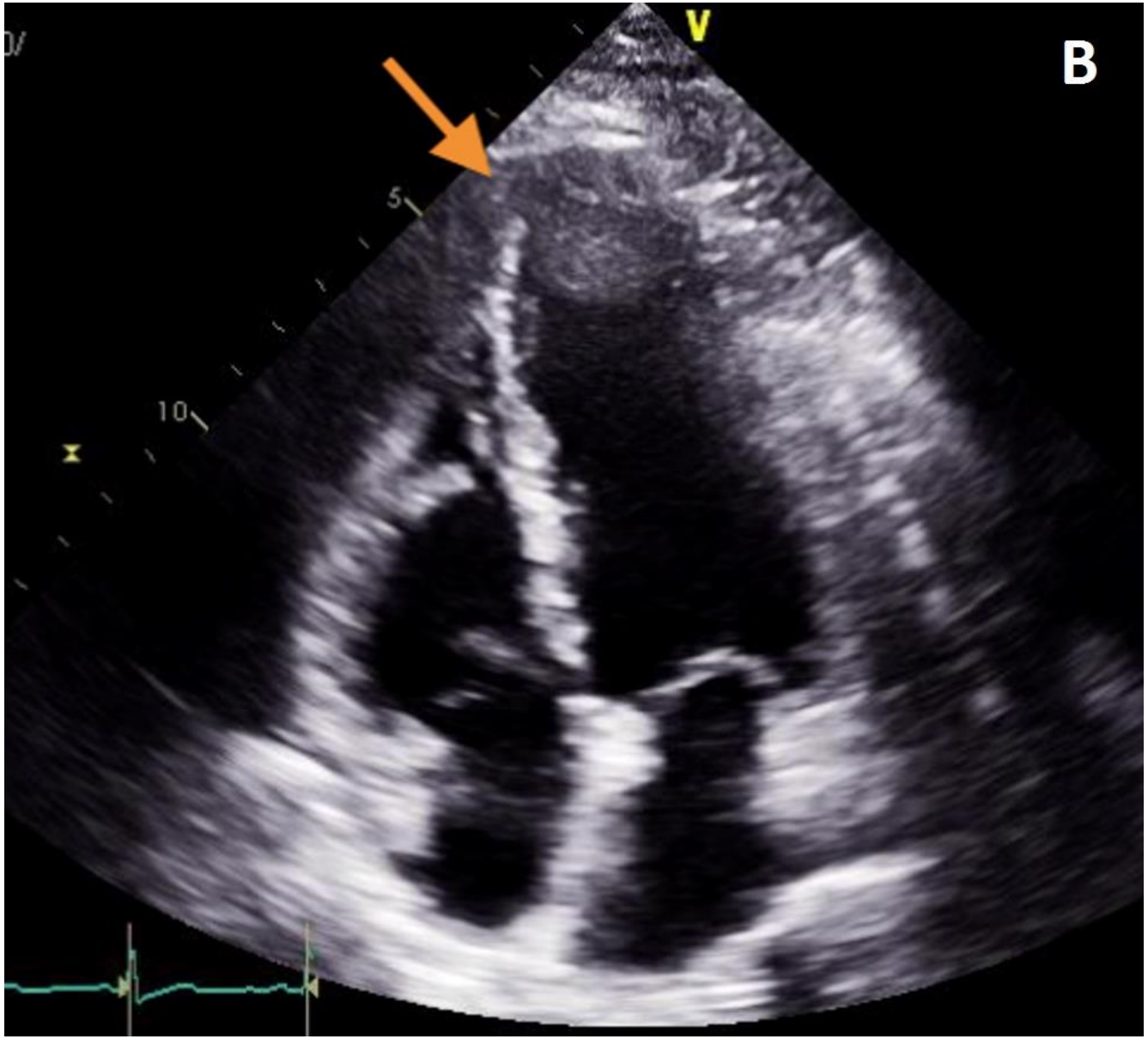
- Select an apical image that has an appropriate sector width and appropriate frame rate.
  - All 3 views should have similar sector widths to avoid frame rate variability.
- Select an image where the left ventricular endocardium and epicardium are within the cardiac cycle. This allows the software to properly track the LV myocardium.





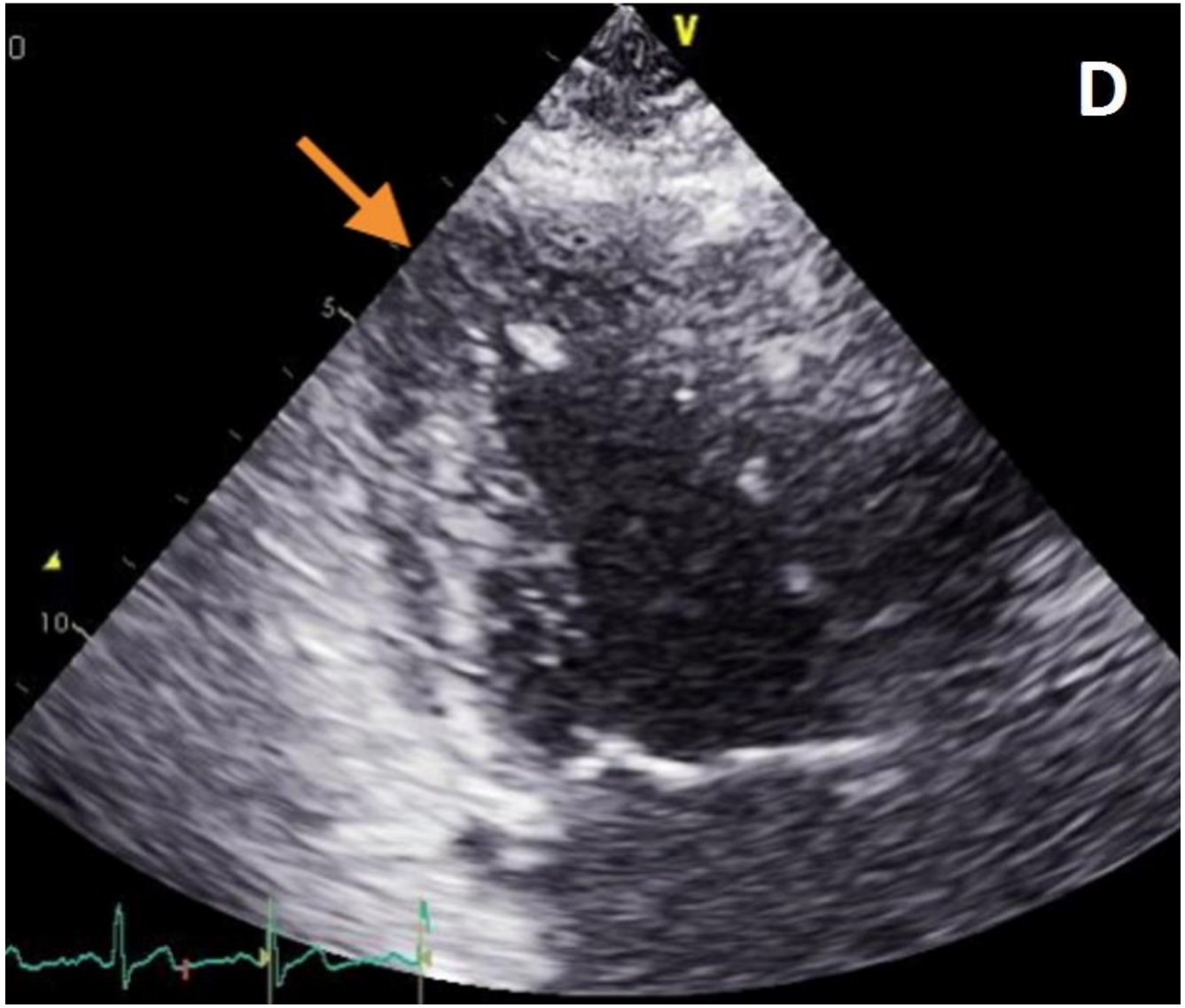
Gain and Focus:

- Select an image where appropriate levels of gain have been used to enhance the visualization of the endocardium, myocardium and epicardium. This will help with border tracking.
- Note the focus placement on the selected image: Select an image that utilizes the focus to improve the visualization of the endocardial borders.



Avoid Foreshortening:

- Select images that are non-foreshortened to avoid suboptimal tracking of all LV wall segments.
  - Foreshortening of apical views has substantial impact on longitudinal strain measurements; predominantly at the apex.



Strain Image Post-Processing Examples

POST-PROCESSING AND ANALYSIS

- It is important to be aware of the following during post processing in order to generate accurate strain measurement results:

1. Image Quality Verification
2. Aortic Valve Closure (AVC) Timing
3. Three Reference Points
4. Define Region-of-Interest (ROI)
5. Reject Segments with Suboptimal Tracking
6. Strain Result

1. Image Quality Verification:

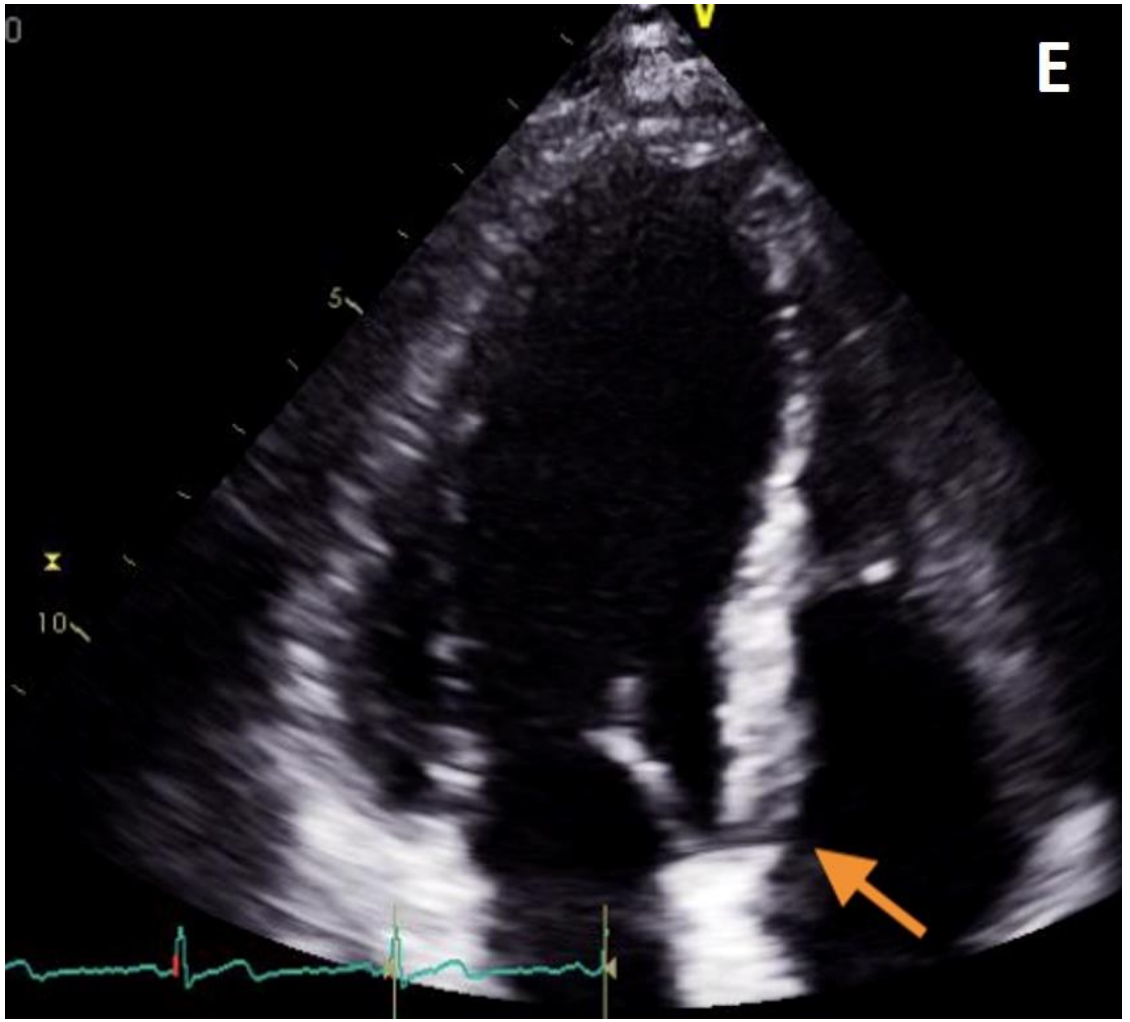
- Pay attention to frame rate, heart rate and image quality prior to selecting the preferred loop.
- The entire LV myocardium and apex should be included in the imaging sector.
- Clear visualization and delineation of LV myocardial borders will provide accurate tracking of the speckles.

2. Aortic Valve Closure (AVC) Timing:

- Ensure accurate ECG signal of the cardiac cycle along with three consecutive beats.
- Visual assessment of the aortic valve closure (AVC) in the AP3ch view is important when selecting the correct end-systolic frame.
- Some vendors allow analysis without an ECG signal. AVC can be automatically detected by the software or manually.
- AVC can be determined using the PW Doppler of the LVOT.

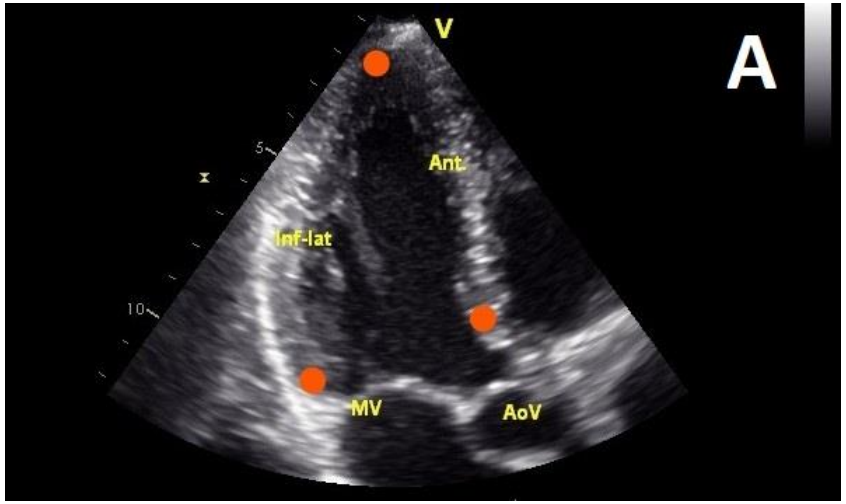
2. Suboptimal Aortic Valve Closure (AVC) Example:

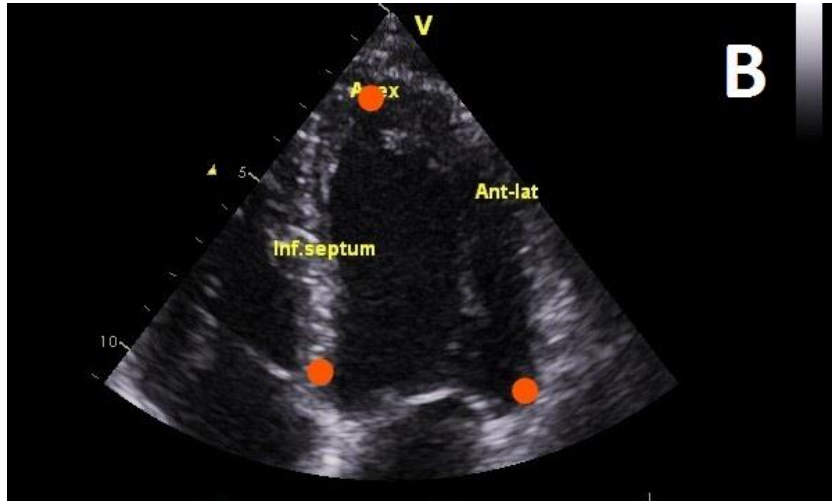
- Select an image that shows an open aortic valve to measure aortic valve closure (AVC) timing.

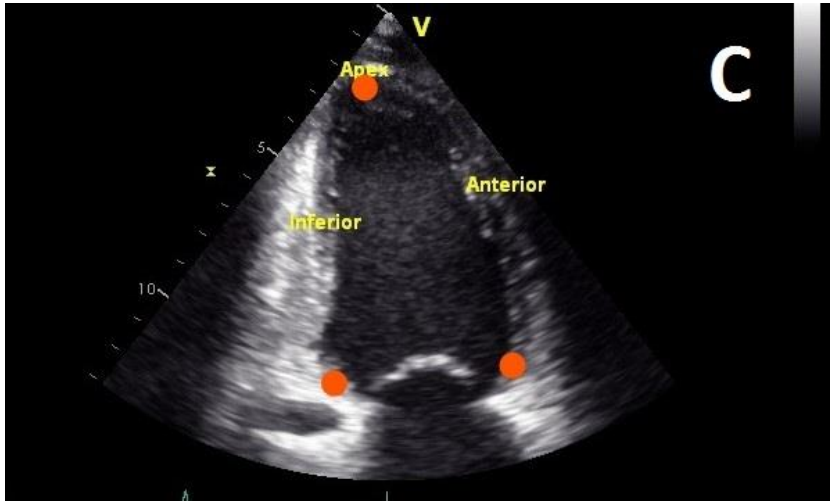


3. Three Reference Points:

- Reference points should be placed:
  - At the blood/tissue border at the level of the LVOT, just more apical to the location of the membranous septum (AP3ch view)
  - In the LV side of the myocardium, past the mitral valve insertion point
  - At the apex



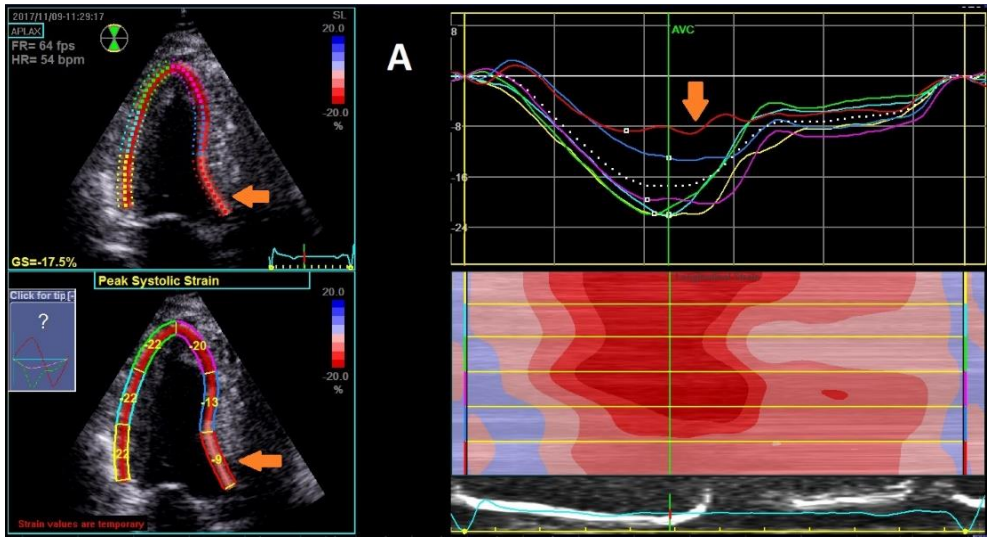


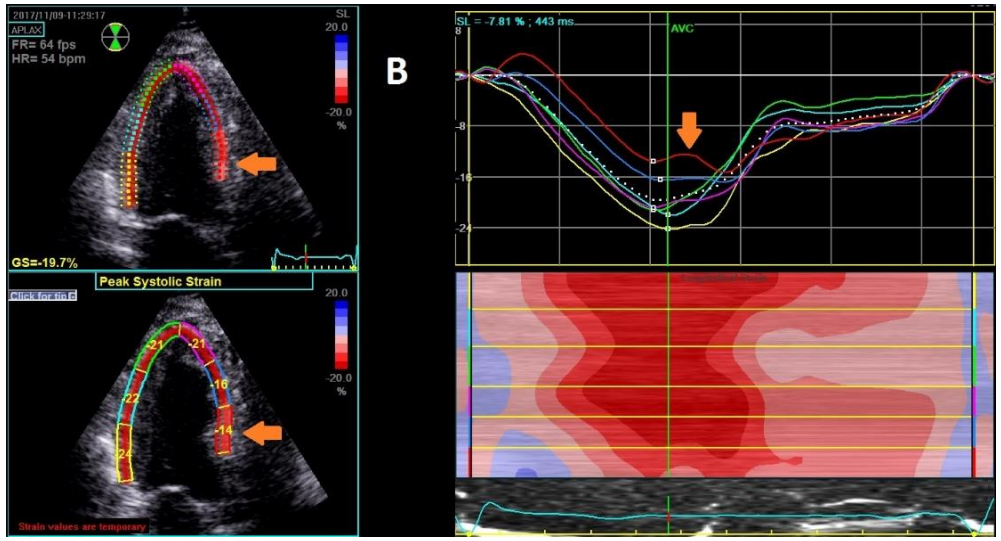


3. Three Reference Points:

- CAUTION : Do not place the reference points on the atrial side of the mitral annulus or into the LV outflow tract. This can cause inaccurate tracking and underestimate the strain value.

3. Three Reference Points Example:



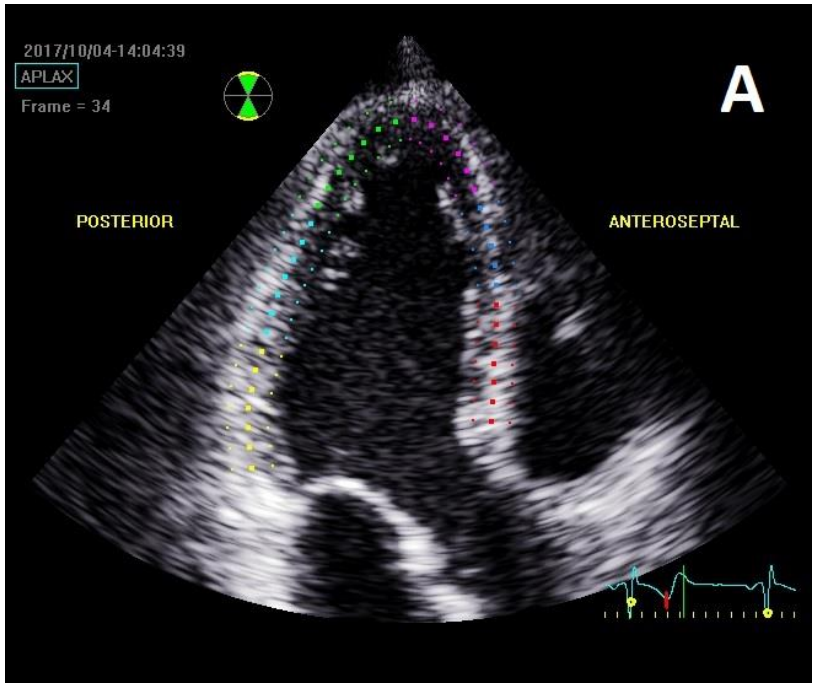


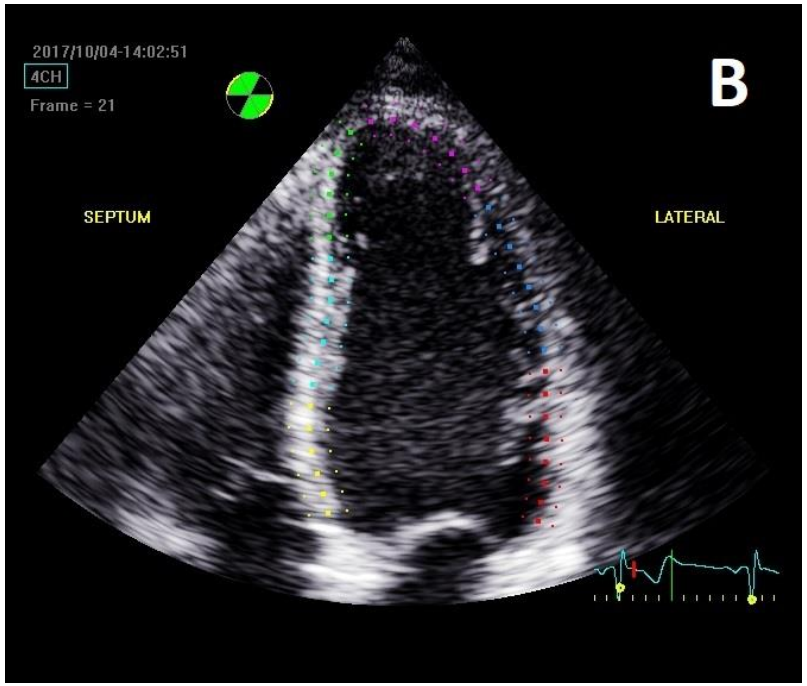
- **Challenge:**
- Reference point placement is too far into the LVOT/on the aortic valve.
- Poor tracking of the basal anteroseptal wall segment (‘red’ color segment on 2D image).
- Results in inaccurately generated strain values as seen on the graph (‘red’ color line on strain curve graph as shown by arrows).

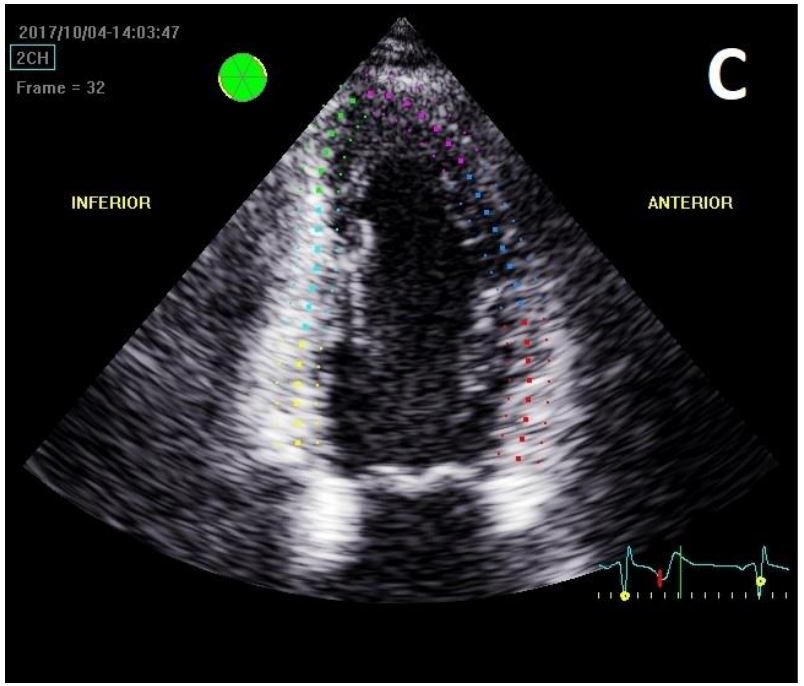
- **Solution:**
- Reference point placement is at the level of the LVOT.
- Better tracking of the basal anteroseptal wall segment on 2D image.
- Accurately generated strain values as seen on strain curve graph (arrows).

4. Define Region-Of-Interest (ROI):

- Tracking can be impaired if the ROI width is too thick or too narrow.
- It is important to include the entire compacted myocardium.
- Avoid including the pericardium.



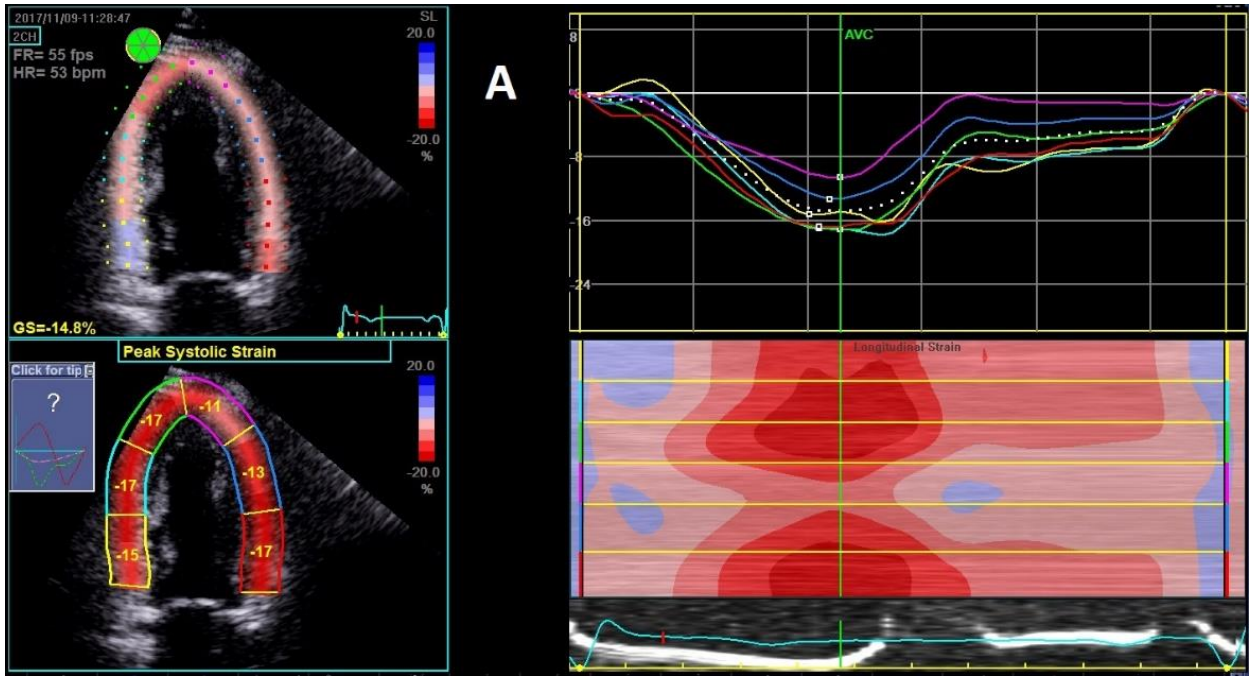




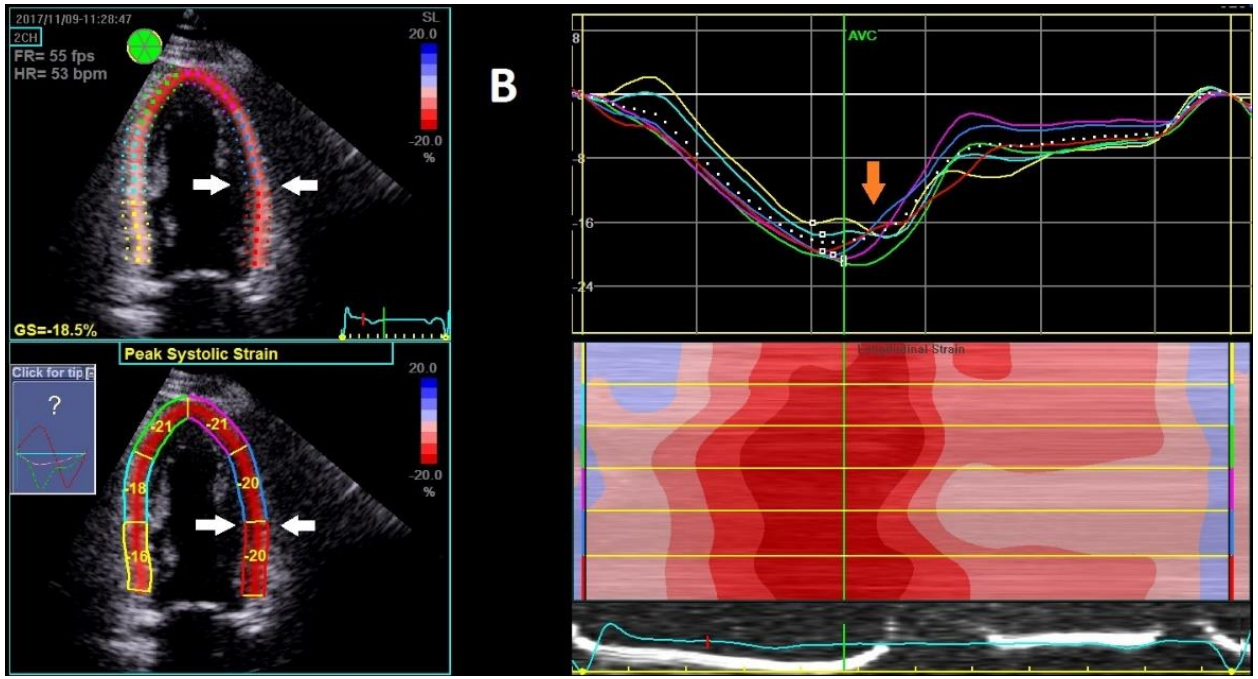
4. Define Region-Of-Interest (ROI):

- CAUTION: Do not include the pericardium. This can reduce the strain value.
- CAUTION: Avoid structures that are not myocardium, such as papillary muscles or false chord.

4. Define Region-Of-Interest (ROI) Example:



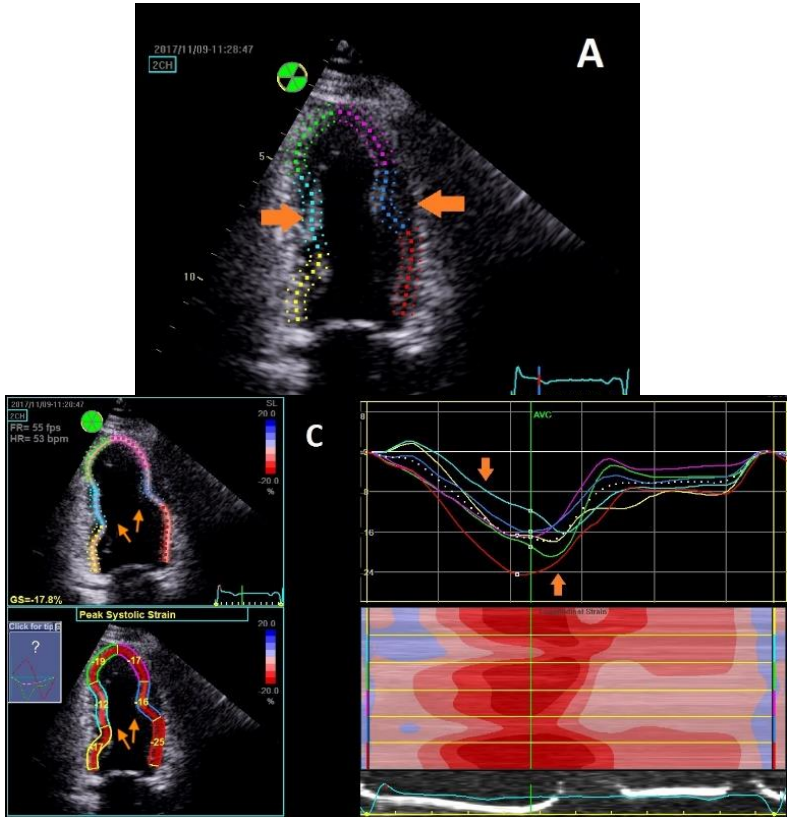
A

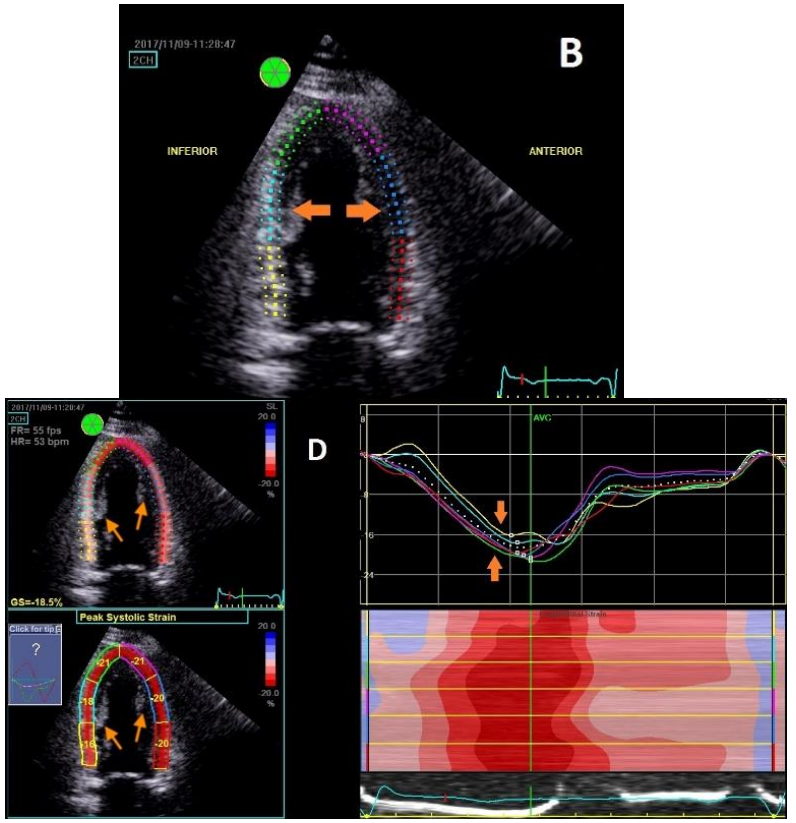


B

• **Challenge:** • Inappropriate ROI width/thickness on the 2D image (white arrow). • Can cause tracking of the pericardium which artificially reduces strain values.	• **Solution:** • Appropriate ROI width/thickness tracking the myocardial borders produces synchronized strain curves.

4. Define Region-Of-Interest (ROI) Example:





- **Challenge:**
- Inclusion of structures within LV cavity that are not myocardial segments.
- False tracking of the papillary muscles (arrows) can result in inaccurate strain values.

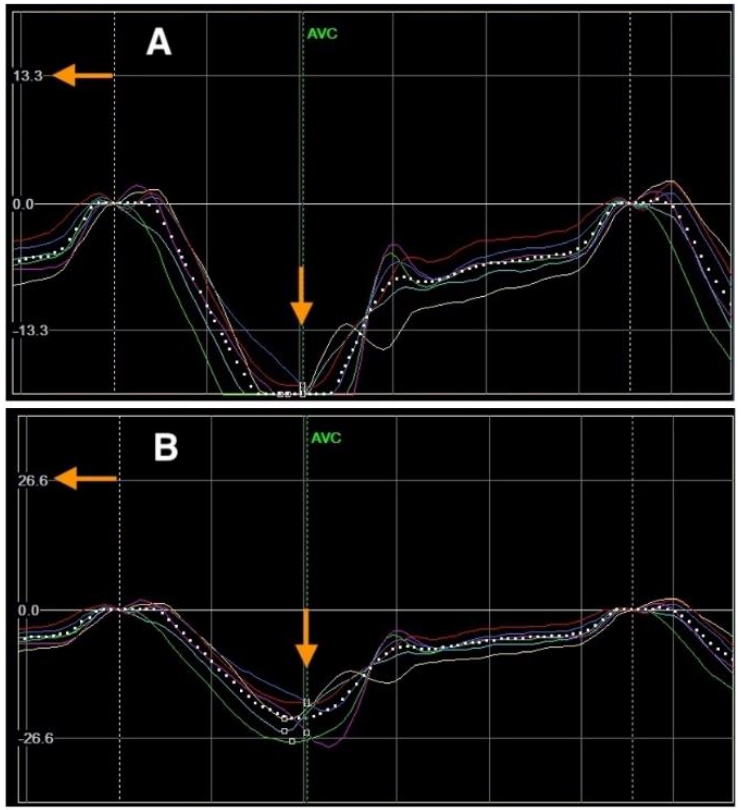
- **Solution:**
- Review acquired cineloop to assess true myocardial motion.
- Ensure ROI does not include papillary muscles or false tendons.

5. Reject Segments with Suboptimal Tracking:

- After setting the ROI, observe the tracking quality of each individual myocardial segments and re-adjust as needed.
- Tracking should follow the motion of the myocardial contraction and movement throughout the cardiac cycle.
- If a myocardial segment has suboptimal tracking, exclude the segment from the final strain calculation.

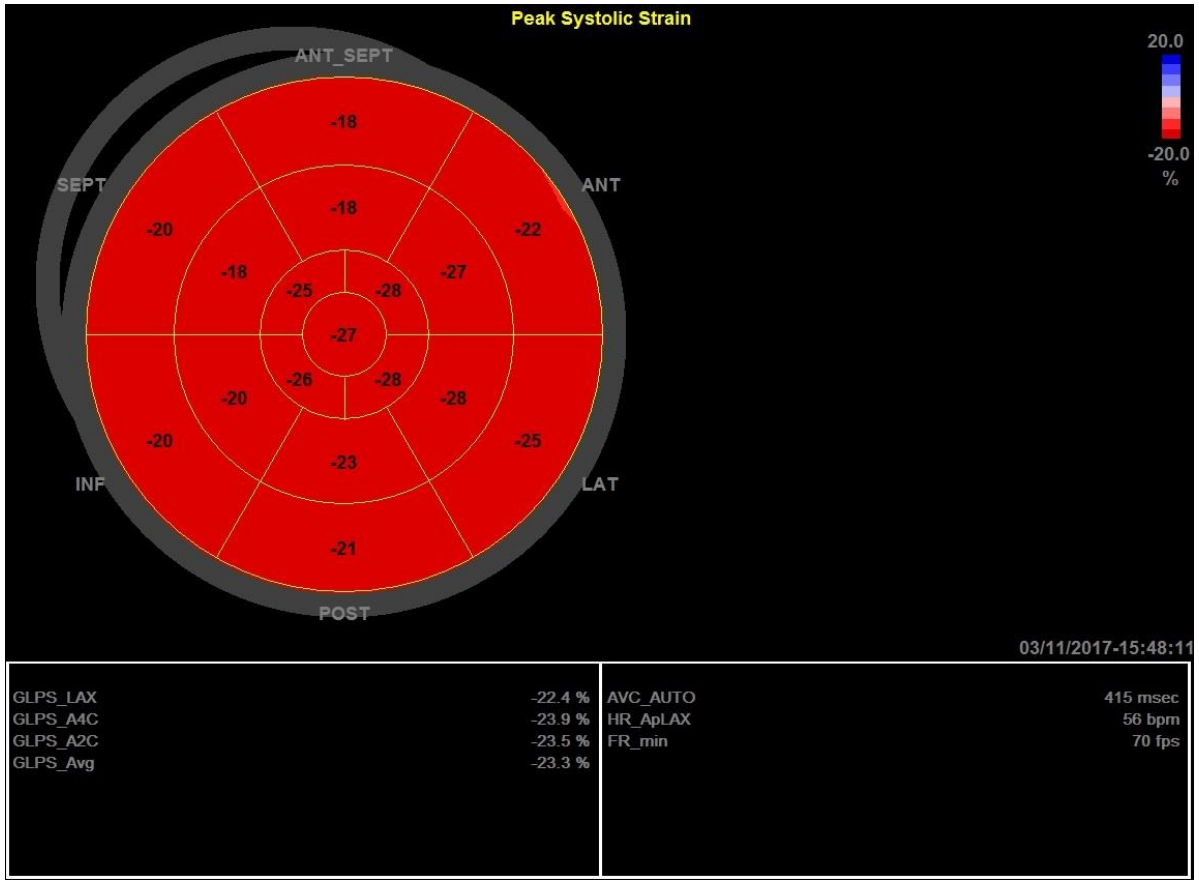
6. Strain Result:

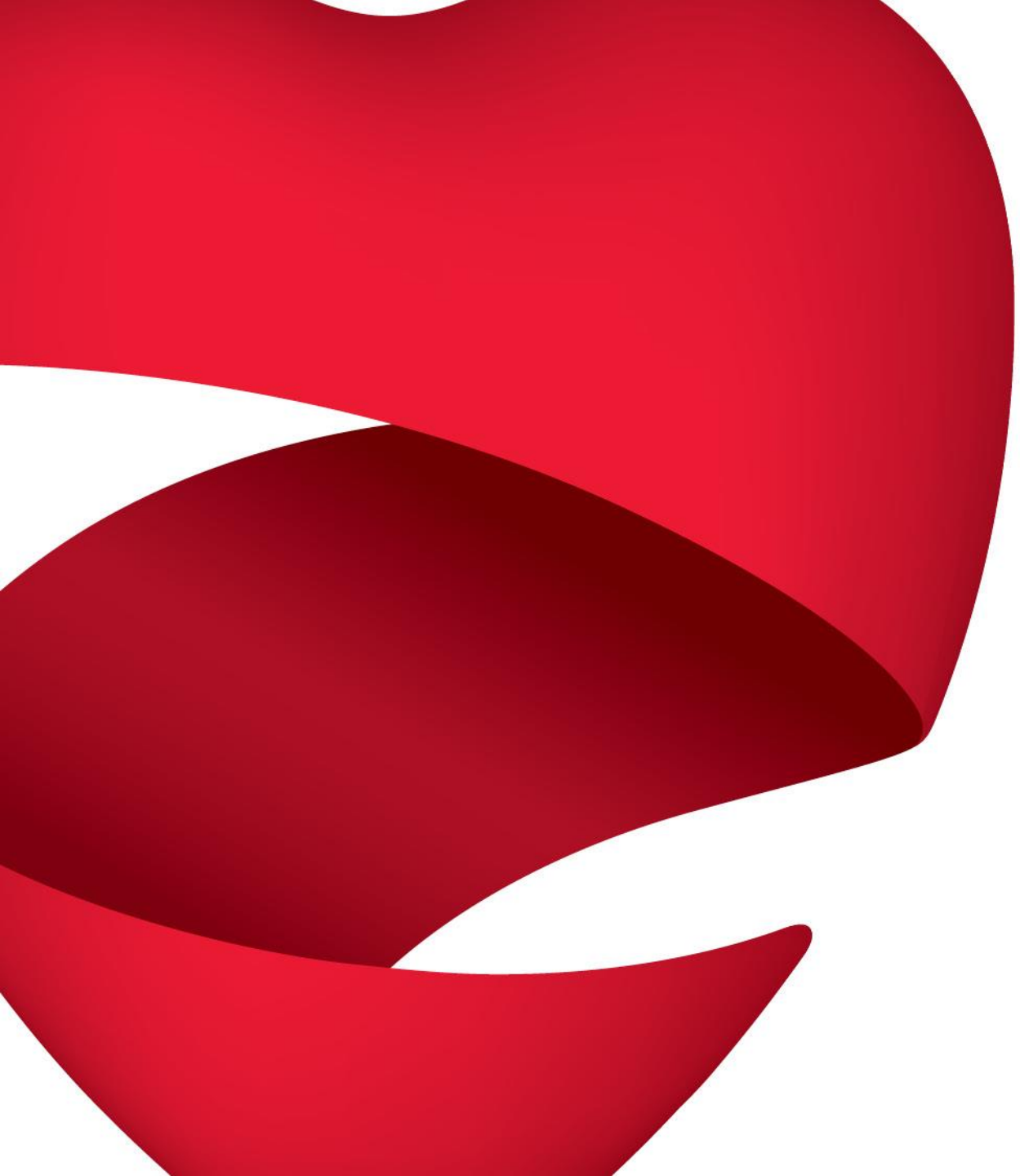
- Once the ROI is approved, the software generates a strain value and strain graph. Adjust the strain graph scale in order to include the entire curve of the graph when storing the analysis.



Analysis

- When post-processing is complete, the software generates a “Bull’s Eye Plot” which displays all the LV segments that were approved for tracking.





TED ROGERS CENTRE FOR HEART RESEARCH

TedRogersResearch.ca

communications@trchr.ca

Partners in the Ted Rogers Centre for Heart Research

SickKids · UHN Toronto General Toronto Western Princess Margaret Toronto Rehab · University of Toronto