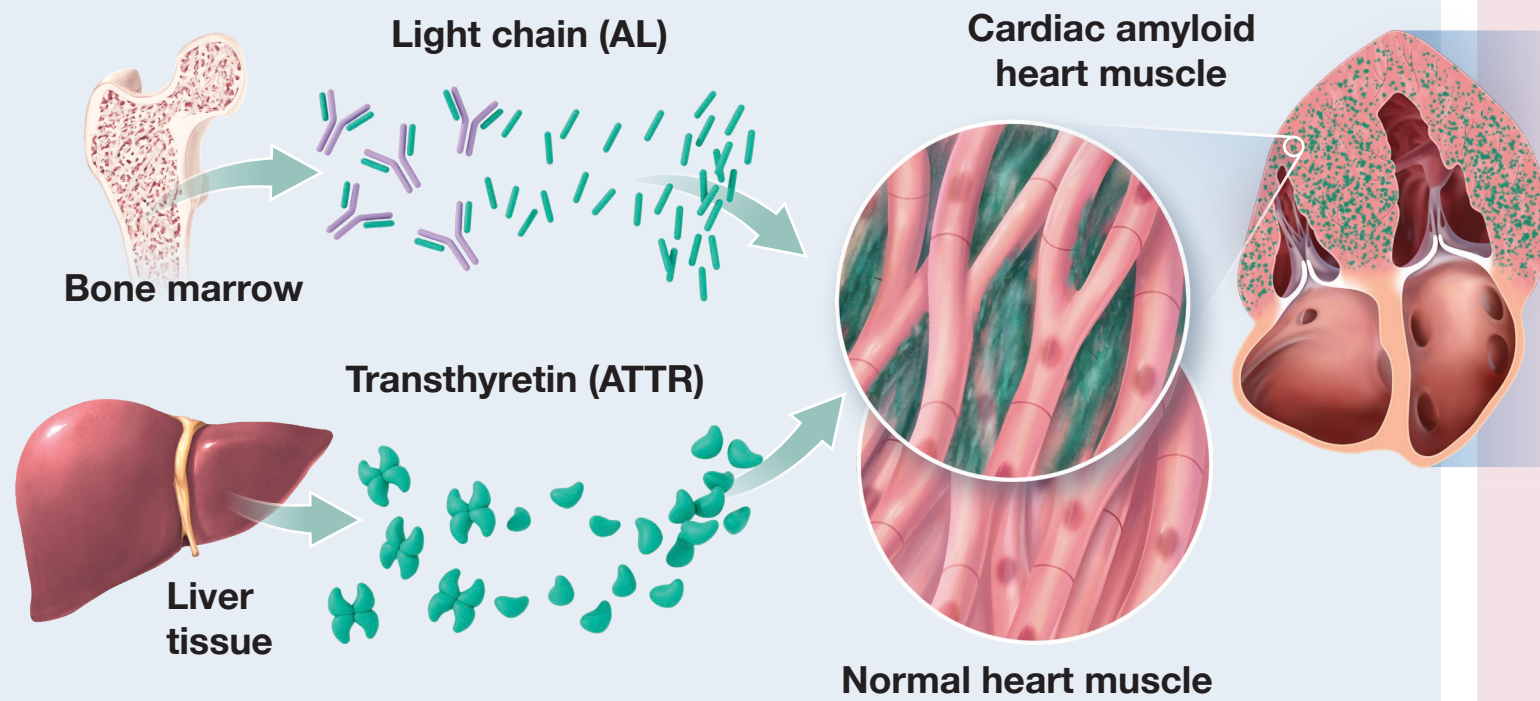


What is Cardiac Amyloidosis (CA)?

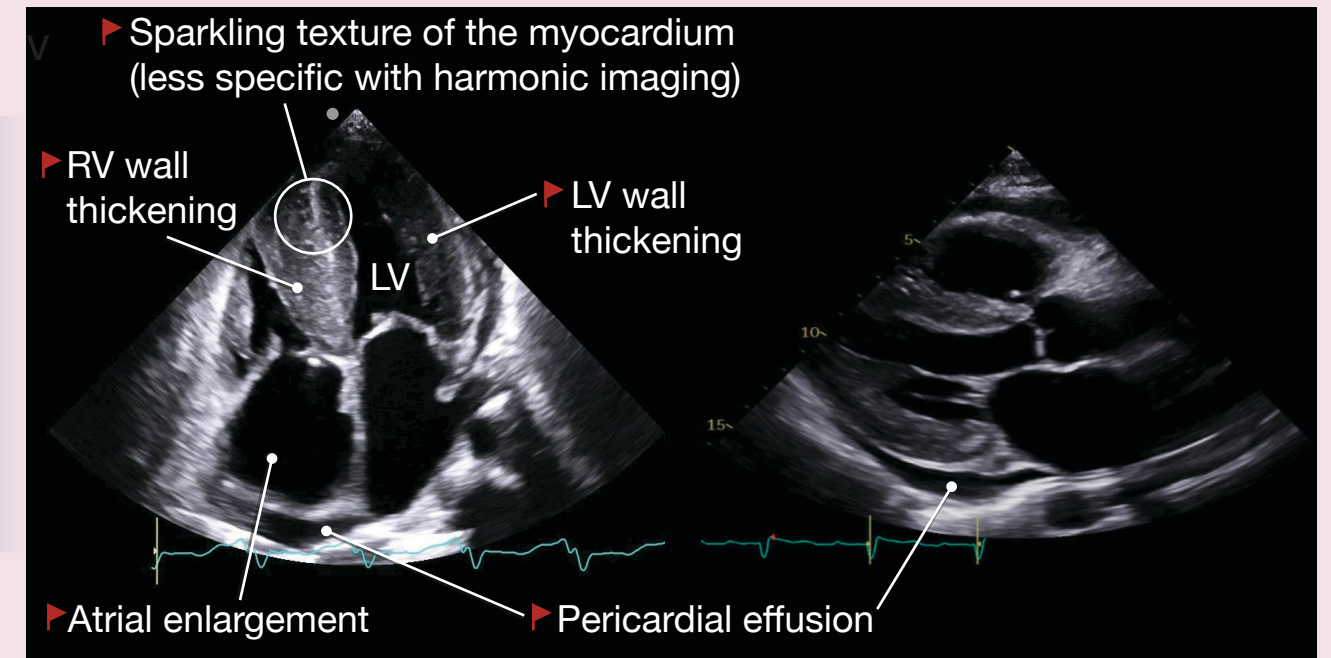
A form of restrictive infiltrative cardiomyopathy due to deposition of amyloid fibrils in the myocardium.

There are 2 common types. Similar echo features are seen in both types of CA.



► Echo Red Flags

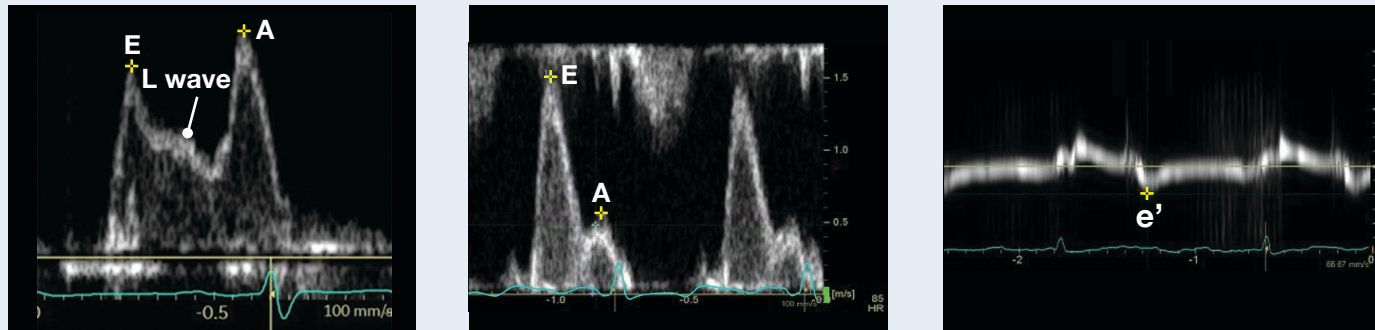
Apical 4 chamber view (left) and parasternal long axis view (right) displaying the typical features of CA.



- Reduced mitral TDI velocities
- Low flow low gradient AS
- Reduced GLS with apical sparing
- Diastolic dysfunction (\geq grade 2)

Doppler Echocardiography in CA

Progressive diastolic dysfunction is a feature of CA. This may only be mildly abnormal in early stages of the disease.



Pulsed wave Doppler of the mitral inflow:

This ranges from a low E/A ratio (<0.8) suggesting restrictive hemodynamics. Abnormal relaxation pattern is less common in CA but may be present in early stage. Note L wave is a clue to elevated filling pressure.

Tissue Doppler:

Strongly suggestive:

- Mitral annular TDI < 5 cm/sec
- Small A wave in sinus rhythm

Not suggestive:

- Septal or lateral tissue Doppler $e' > 10$ cm/s

Rule of 5 (5-5-5)

All e' , a' , s' velocities < 5 cm/s

This is a clue to the diagnosis of CA.

Clinical Red Flags

- Heart failure
- Nephrotic syndrome
- Peripheral or autonomic neuropathy
- Weight loss
- Bilateral carpal tunnel
- Spinal stenosis
- Periorbital purpura

Strain Analysis in CA

Myocardial deformation ("strain") measured by 2-dimensional speckle tracking imaging is very useful in CA. Longitudinal strain is the measure of the longitudinal contractile function of the heart.

When to do strain:

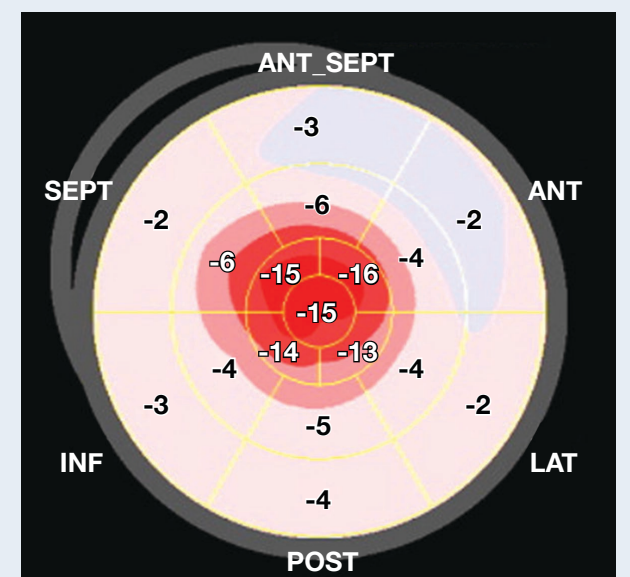
If feasible anytime there is increased LV wall thickness, especially in:

- Over 65 year olds
- Heart failure
- No history of poorly controlled HTN

Global longitudinal strain (GLS):

Normal values of GLS vary between vendors; normal is usually considered to be more negative than -20% with an SD of $\pm 2\%$ (lower limit of normal -16% to -18% , depending on vendor).

Values nearing 0% suggest more dysfunction and either advanced disease or disease progression.



Strain pattern:

In cardiac amyloidosis the segmental strain curves representing the apical segments will have a further deflection away from the 0 line than the curves representing the basal segments. When plotted on a bullseye, this will generate a characteristic "apical sparing" pattern visually.

Strain ratios:

Longitudinal strain ratios that have been described, with the diagnostic cutoffs used in the original publications: proposed ratios incorporating LV GLS for diagnosis of CA.

Key Points

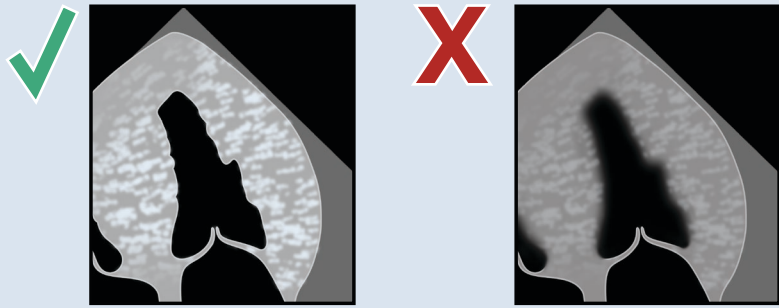
- Echo may be the first clue to the diagnosis of amyloidosis.
- Classic: thickened myocardium, diastolic dysfunction, and abnormal strain (apical sparing)
- Atypical or subtle findings may be seen in early disease
- Consider strain imaging whenever amyloid suspected
- Echo alone is not diagnostic of CA, nor can it differentiate between AL and ATTR.



Tips for Performing Strain Analysis

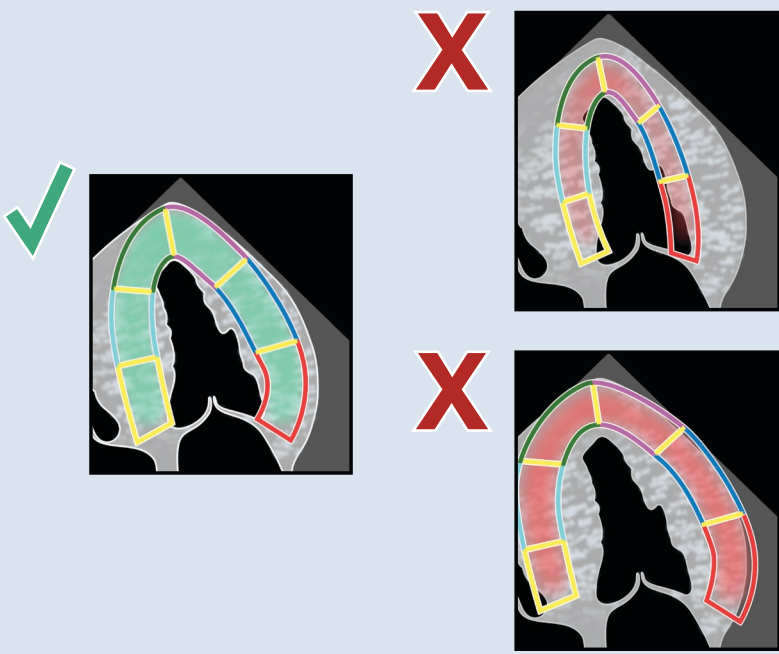
► Increased gain:

Higher gain results in more speckles; need good endocardial definition.



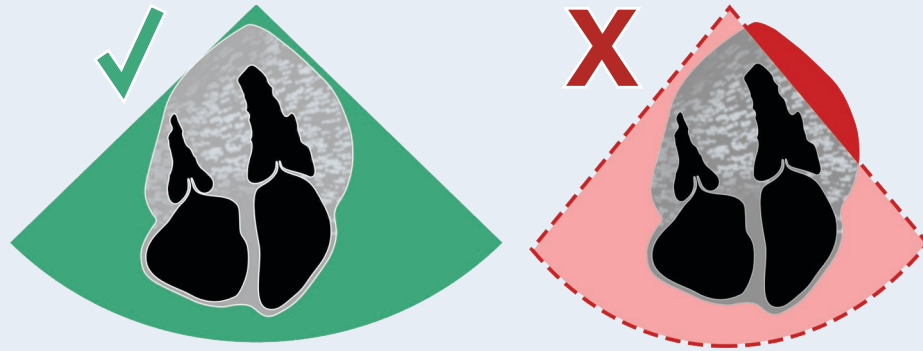
► Region of interest (ROI):

Include 90% of the myocardium as error can occur if too narrow, favoring epicardial or endocardial regions. If too wide, it can lead to abnormal, often lower, values.



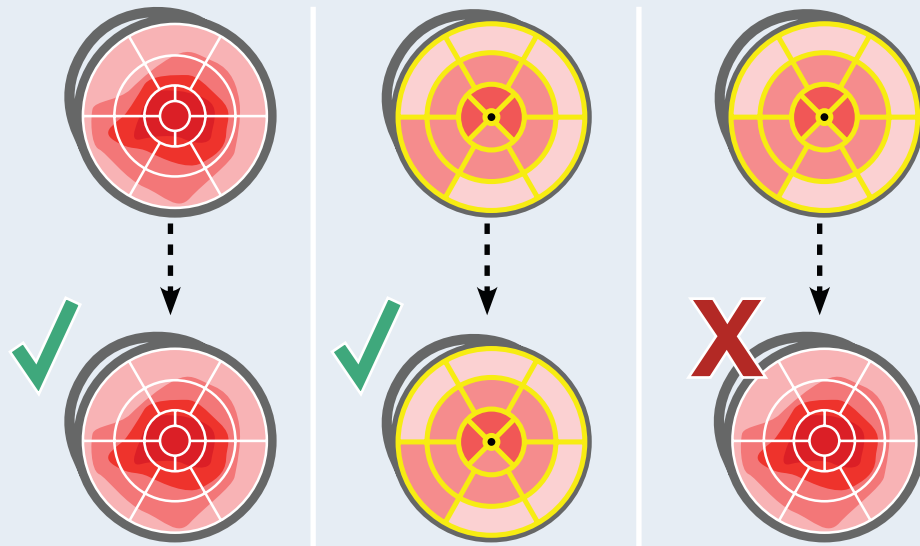
► Consistent sector width and depth:

Wide enough to include the full wall thickness and apex and extend beyond annulus to allow capture of entire LV throughout cardiac cycle.



► Longitudinal follow-up:

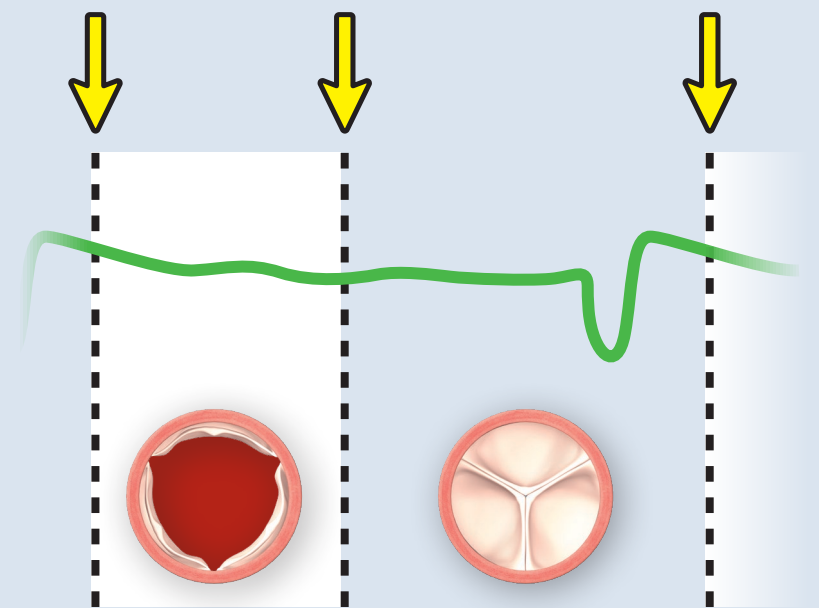
Using a consistent vendor allows for better comparisons over time.



► ECG gating and timing of end diastole and end systole to aortic valve opening and closing:

It is very important for evaluation of end-systolic versus peak strain values; deformation after aortic valve closure is not relevant.

If ECG gating is incorrect, e.g., tracking p wave, may need to manually adjust off-line.



Standardized Acquisition and Interpretation of Echocardiography for CA

(Adapted from Expert Consensus Recommendations*)

Parameter for acquisition and reporting	Abnormal parameter	Notes
LV wall thickness	Increased LV wall thickness (>1.2 cm) and increased relative wall thickness (>0.42)	Discordance between increased LV wall thickness relative to ECG QRS voltage is particularly suggestive, but normal ECG voltage can also be seen.
Myocardial echogenicity	Increased echogenicity of the myocardium (sparkling, hyperrefractile “texture” of the myocardium)	Not highly specific (differential diagnosis includes endstage renal disease or other infiltrative cardiomyopathies); highly suggestive in conjunction with severely reduced longitudinal function of the LV.
Atrial size and function	Atrial enlargement and dysfunction (see diastolic function)	Nonspecific but important finding to support the diagnosis and potentially provide insight into risk for stroke or arterial embolism.
Interatrial septum and valves	Increased thickening of the interatrial septum and valves (>0.5 cm)	Nonspecific but suggestive of the diagnosis.
Estimated PA systolic and right atrial pressure	Increased pressures (>35 mm Hg for PA, ≥10 mm Hg for right atrium)	These are important parameters to estimate volume status and optimize diuretic dosing.

LS, Longitudinal strain;
PA, pulmonary artery.

*Dorbala S, et al. ASNC/AHA/ASE/EANM/HFSA/ISA/SCMR/SNMMI expert consensus recommendations for multimodality imaging in cardiac amyloidosis: part 1 of 2—evidence base and standardized methods of imaging. J Nucl Cardiol 2019;26:2065-123.

