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.

- Light chain (AL)
- Transthyretin (ATTR)
- Cardiac amyloid heart muscle
- Normal heart muscle
- Bone marrow
- Liver tissue

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

- Sparkling texture of the myocardium (less specific with harmonic imaging)
- RV wall thickening
- LV wall thickening
- Atrial enlargement
- Pericardial effusion
- Reduced mitral TDI velocities
- Reduced GLS with apical sparing
- Low flow low gradient AS
- Diastolic dysfunction (≥ grade 2)

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

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.

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 -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.

Access resources on Amyloidosis and full Journal article: ASEcho.org

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### Tips for Performing Strain Analysis

- **Increased gain:** Higher gain results in more speckles; need good endocardial definition.
- **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.
- **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.
- **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.
- **Longitudinal follow-up:** Using a consistent vendor allows for better comparisons over time.

### Standardized Acquisition and Interpretation of Echocardiography for CA

**Adapted from Expert Consensus Recommendations**

<table>
<thead>
<tr>
<th>Parameter for acquisition and reporting</th>
<th>Abnormal parameter</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>LV wall thickness</td>
<td>Increased LV wall thickness (&gt;1.2 cm) and increased relative wall thickness (&gt;0.42)</td>
<td>Discordance between increased LV wall thickness relative to ECG QRS voltage is particularly suggestive, but normal ECG voltage can also be seen.</td>
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<tr>
<td>Myocardial echogenicity</td>
<td>Increased echogenicity of the myocardium (sparkling, hypereflective “texture” of the myocardium)</td>
<td>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.</td>
</tr>
<tr>
<td>Atrial size and function</td>
<td>Atrial enlargement and dysfunction (see diastolic function)</td>
<td>Nonspecific but important finding to support the diagnosis and potentially provide insight into risk for stroke or arterial embolism.</td>
</tr>
<tr>
<td>Interatrial septum and valves</td>
<td>Increased thickening of the interatrial septum and valves (&gt;0.5 cm)</td>
<td>Nonspecific but suggestive of the diagnosis.</td>
</tr>
<tr>
<td>Estimated PA systolic and right atrial pressure</td>
<td>Increased pressures (&gt;35 mm Hg for PA, ≥10 mm Hg for right atrium)</td>
<td>These are important parameters to estimate volume status and optimize diuretic dosing.</td>
</tr>
</tbody>
</table>

LS, Longitudinal strain; PA, pulmonary artery.