Left atrial Function In Echocardiography

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Diastole

LA Volume

LA Pressure (mmHg)

A-Loop

V-Loop

LA function
At atrial function, the QRS complexes are correlated to the LV filling pressure & LA compliance. Booster pump F is influenced by:
- LV Compliance
- LV enddiastolic Pr.
- LA intrinsic contractility

- Correlated to LV relaxation systole & diastole.

Donal et al JASE 2006
Atrium as Ventricle is remodeling

- **Electrical**
  - ↓ ADP
  - ↓ AFCI
  - ↓ θ
  - ↓ Wavelength*

- **Structural**
  - ↓ Contractility
  - ↓ Dilatation
  - ↓ Connexins
  - ↓ Anisotropy
  - ↑ Compliance

- **AF**
  - ↓ Cytosolic Ca++

- **Contractile**
  - ↓ Ca++ channels

- **Stretch**
  - ↓ Circuit size

* Wavelength (shortening of refractoriness and slowing of conduction

Indices of Atriale emptying: (not used in clinical routine)

1. LA total emptying volume index = $LAVI_{\text{max}} \times LAVI_{\text{min}}$
2. LA passive emptying volume index = $LAVI_{\text{max}} \times LAVI_{\text{pre-a}}$
3. LA active emptying volume index = $LAVI_{\text{pre-a}} \times LAVI_{\text{min}}$

**Reservoir Function**: 2 indices:

1. expansion index = \[\frac{(LAVI_{\text{max}} - LAVI_{\text{min}})}{LAVI_{\text{min}}}\times 100\]

2. diastolic emptying index = \[\frac{(LAVI_{\text{max}} - LAVI_{\text{min}})}{LAVI_{\text{max}}}\times 100\]

*Stefanadis et al. Eur H J 2001 & Manning JACC 1993*
Conduit Function: 2 indices:

1. passive emptying % of total emptying = 

\[
\left(\frac{LAVI_{\text{max}} \times LAVI_{\text{pre-a}}}{LAVI_{\text{max}} \times LAVI_{\text{min}}}\right) \times 100
\]

2. passive emptying index = 

\[
\left(\frac{LAVI_{\text{max}} \times LAVI_{\text{pre-a}}}{LAVI_{\text{max}}}ight) \times 100
\]

Booster pump function:  
2 indices:

1. active emptying percentage of total emptying = $$\frac{[(LAVI_{pre-a} - LAVI_{min})/(LAVI_{max} - LAVI_{min})] \times 100}{LAVI_{pre-a} - LAVI_{min}}$$

2. active emptying index = $$\frac{(LAVI_{pre-a} - LAVI_{min})}{LAVI_{pre-a}} \times 100.$$
LA Volume assessed by 3D-TTE

Marsan et al. Am J Cardiol 2008
Deformation of Atrial Myocardium
Semi-automatic borders detection

Strain (%)

Strain Rate (s⁻¹)
LA SYSTOLIC POSITIVE PEAK:
LA RESERVOIR CAPABILITY
The speckle tracking approach improves deeply the robustness.

Intra-observer variability = 8%

Inter-observer variability 9.5%

Time required for the LA function assessment 3.8 minutes

Paraskevaidis IA et al. Heart 2009;95:483-489
Index of backscattering

84%
56%
28%

Normal
GLOBAL ATRIAL SYSTOLIC AND DIASTOLIC STRAIN RATE are:

I. Highly sensitive

II. Load dependent

III. Related somehow to LV longitudinal function

IV. Age related (changes have been demonstrated very early before ATRIAL PHASIC VOLUME PARAMETERS.)

Boyd et al. Heart 2011; 97: 1513
LA-deformations are impaired in patients with hypertension and diabetes with normal LA size.

- with ageing
  - LA conduit ↓
  - LA reservoir is supposed to be constant
  - LA booster pump function increase slightly

Stroke 2014; 45(8):e164-e166
JASE 2011; 24: 898-908
Heart 2011; 97: 1513
contractile left atrial (LA) strain in patients with hypertrophic cardiomyopathy (HCM), hypertension or aortic stenosis (HT/AS) and normal controls.

LA Reservoir:
- HCM 22±8%
- LVH 38±4%
- Control 42±4%

Paraskevaidis IA et al. Heart 2009;95:483-489
Global Peak Atrial Longitudinal Strain (%) vs. Atrial Fibrosis (%)

R = -0.8240
P < 0.0001

Cameli et al. Am J cardiol 2013
Left Atrial Strain and Strain Rate in Patients With Paroxysmal and Persistent Atrial Fibrillation: Relationship to Left Atrial Structural Remodeling Detected by Delayed-Enhancement MRI

**Conclusions**—LA wall fibrosis by delayed-enhancement MRI is inversely related to LA strain and strain rate, and these are related to the AF burden. Echocardiographic assessment of LA structural and functional remodeling is quick and feasible and may be helpful in predicting outcomes in AF. *(Circ Cardiovasc Imaging. 2010;3:231-239.)*
LA Strain Provides Incremental Value for Embolism Risk Stratification over CHA2DS2-VASc Score and Indicates Prognostic Impact in Patients with AFib

Methods: Consecutive patients with paroxysmal or persistent AF with acute embolism (82 patients) or without (20 controls) were prospectively enrolled. Global peak LA longitudinal strain during ventricular systole (LAs) was assessed during AF rhythm. Global LAs was compared between the groups in the first cross-sectional study. Then, the 82 patients with acute embolism were prospectively followed during the second prospective cohort study.

Conclusions: In this observational study, LA strain provided incremental diagnostic information over that provided by the CHA2DS2-VASc score, suggesting that LA strain analysis could improve the current risk stratification of embolism in patients with AF. LA strain can also predict poststroke mortality. (J Am Soc Echocardiogr 2014;27:709-16.)
### Global \( \chi^2 \)

<table>
<thead>
<tr>
<th>Models</th>
<th>Model 1 (( \chi^2 ) 12.8)</th>
<th>Model 2 (( \chi^2 ) 67.4)</th>
<th>Model 3 (( \chi^2 ) 83.9)</th>
<th>Model 4 (( \chi^2 ) 132.4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>( \text{CHA}_2\text{DS}_2\text{-VASc score} )</td>
<td>+ OAC use</td>
<td>+ LA emptying fraction</td>
<td>+ Global LA₅</td>
</tr>
<tr>
<td>( \text{CHA}_2\text{DS}_2\text{-VASc score} )</td>
<td>1.35 (1.14-1.61) ( P &lt; .001 )</td>
<td>1.47 (1.21-1.79) ( P &lt; .001 )</td>
<td>1.45 (1.19-1.76) ( P &lt; .001 )</td>
<td>1.11 (0.88-1.40) ( P = .362 )</td>
</tr>
<tr>
<td>OAC use</td>
<td>-</td>
<td>0.12 (0.06-0.22) ( P &lt; .001 )</td>
<td>0.12 (0.06-0.23) ( P &lt; .001 )</td>
<td>0.10 (0.05-0.21) ( P &lt; .001 )</td>
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<tr>
<td>LA emptying fraction</td>
<td>-</td>
<td>-</td>
<td>0.95 (0.92-0.98) ( P &lt; .001 )</td>
<td>0.98 (0.95-1.01) ( P = .151 )</td>
</tr>
<tr>
<td>Global LA₅</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.75 (0.68-0.83) ( P &lt; .001 )</td>
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Log-rank test

Global $L_A > 12.0\%$

Global $L_A \leq 12.0\%$

$P = .007$

<table>
<thead>
<tr>
<th>Global $L_A$ &gt; 12.0%</th>
<th>41</th>
<th>34</th>
<th>10</th>
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<td>Global $L_A$ \leq 12.0%</td>
<td>41</td>
<td>22</td>
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effects of RF-Ablation of paroxysmal or persistent Afib on left atrial function

LA Lateral ε (%)
O: maintained SINUS Rhythm

- recurrence of A Fib
- * P <0.05

Global LA Strain in the Prediction of Sinus Rhythm Maintenance after Catheter Ablation for AFib

Methods: In 256 patients with AF (paroxysmal, 204; persistent, 52), comprehensive echocardiography was performed with assessment of LAε by using Velocity Vector Imaging to calculate average strain values from apical four- and two-chamber views before ablation (median, 41 days; interquartile range, 1–95 days).
Sensitivity vs. 1-specificity plot for different measurements:
- \( \text{LA}\epsilon_{\text{total}} \) (AUC=0.73±0.03), \( P<.001 \)
- Total LAEF (AUC=0.64±0.03)*, \( P<.001 \)
- Max LAVi (AUC=0.59±0.04)*, \( P=.010 \)

*\( P<.001 \) vs. \( \text{LA}\epsilon_{\text{total}} \)
AF free survival

Log-rank: $P<.001$

Number at risk

<table>
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<tr>
<th>Number at risk</th>
<th>$\geq 23.2$</th>
<th>$&lt; 23.2$</th>
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<tr>
<td>$\geq 23.2$</td>
<td>127</td>
<td>129</td>
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<td>23</td>
<td>21</td>
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$LA\varepsilon_{\text{total}} \geq 23.2$

$LA\varepsilon_{\text{total}} < 23.2$
clinical features: age, sex, AF duration, AF type, prior AF ablation, CHADS2 score, and permanent pacemaker or cardioverter-defibrillator implantation.
ROC-curve of LASs for predicting arrhythmia elimination with a second radiofrequency catheter ablation.

Keep in mind a cut-off value of +/-20%.

Left atrial deformation predicts success of first and second percutaneous AF on ablation.

Silvia Montserrat et al Heart Rhythm, 2014
Take Home messages

Atrial function can be assessed especially using the speckle tracking approach for a relevant assessment of LA Remodeling in many clinical condition.

Great expectations for the assessment of the atrial Reservoir function in many clinical condition.

A lot of researches and validations remain necessary.
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- Cardiac Computed Tomography and Nuclear Cardiology

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