EVALUATION OF the LEFT ATRIAL APPENDAGE
Thrombus and Spontaneous Contrast

No disclosures related to this presentation

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Rheumatic Mitral Stenosis
INCIDENTAL FINDING
Intra op TEE pre AVR/CABG

86 y/o female presenting for a pre Watchman evaluation has permanent AF, hx GI bleedng and is very frail with falling episodes. What would be the best descriptor for the finding shown?

1. “Faint” LAA sludge
2. “Dense” LAA sludge and thrombus
3. Severe LAA spontaneous echo contrast
4. Left atrial myxoma
5. Mitral valve obstruction with slow forward flow
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Why is discussion of the LAA important?

• AF occurs in 0.4-1% of the USA population
  • >8% in those >80 years of age
  • Prevalence projected to double by 2035
• Thrombi form in the LA in the presence of AF
  • Reduced contractility and stasis
• Frequent need to assess risk
  • Stroke – frequent association with AF (unrecognized)
  • Pre Cardioversion
  • During interventional transcath procedures
In contrast, in USA reductions in annual Stroke incidence of >1% from 1980-2000

**PROJECTION TO YEAR 2050**

Stroke in USA
- 140,000 per year
- 1 in 20 deaths
- 87% ischemic
- $34 billion/year
Effects of AF on Function predispose to Thrombus

- Decrease in contractility
- Dilation of the LAA
- Decrease in doppler velocities
- Minimal change in systole and diastole

Factors involved in LAA thrombus formation

- Platelet activation
- Platelet thromboglobulin
- Thromboembolism and stroke
- Coagulation cascade activation
  - TPA dimer
  - Prothrombin 1 and 2
  - Thrombin and thrombin complex
- Endothelial damage/dysfunction
- Atrial tissue changes
  - Myocyte hypertrophy
  - Scarring
  - Fibrosis
  - Extracellular matrix abnormal changes
  - Re-entry focal wave
LEFT ATRIAL MECHANICAL FUNCTION
Post Surgical MAZE with NSR

ABNORMAL
Post LAA ablation with NSR
Thrombus

- A powerful predictor of risk
- Stands as the only absolute contraindication to CDV
- Mandates anticoagulation therapy until resolution
- Data from multiple sources confirm the efficacy of risk reduction with warfarin and NOAC
80 y/o healthy female
New AF with flu-like illness.
Hx HTN HLD
POST MVR with chronic AF
Inadequate anticoagulation

93 y/o male referred for TAVR
Low Flow Low Gradient AS with LVEF 40%

LAA velocity 27 cm/sec
Pre TAVR Outpatient TEE  
3 month F/U post OAC

IMAGING TO DETECT LAA THROMBI

- **ECHOCARDIOGRAPHY (TEE)**
  - Sensitivity 92% Specificity 98%
  - Compared with intraop observation (Ann Int Med 1995)
- **ECHO TECHNIQUES**
  - 2D AND 3D Imaging in multiple views
  - Multiplanar reconstruction
  - Ultrasound contrast
  - Spectral doppler velocities
  - Tissue doppler and strain

*Intracardic echo - ? less sensitive*
LAA INTERIOR FINDINGS
Sources of Confusion

JACC IMAG 2014;7:1251

Application of 3D TEE
Use of Contrast and Color Doppler with Low Aliasing

Use of echo contrast to confirm thrombus
CLOUDINESS IN THE LA AND LAA DIFFERENTIATION

• SPONTANEOUS ECHO CONTRAST
  • Swirling echo density with the LA or LAA imaged with gain set to diminish background
  • Dense: continuously seen
  • Faint: intermittent

• “SLUDGE”
  • Viscous, gelatinous morphology without consistent form

• THROMBUS
  • Organized echo density with defined border, often oscillating

JASE 2014:27:1176
Elderly male with reduced LVEF, AS and chronic AF post PPM
Clinical Significance of SEC

- Found in 12-67% of AF patients

- Associated with clinical predictors of stroke
  - Older age, previous thromboembolism, HTN, constant AF
  - Larger LA and LAA size and volumes
  - Lower LA emptying velocities (<20 cm/sec)
  - Presence of LAA thrombus

- Dense SEC without anticoagulation
  - 3X greater rate of stroke

SEC: Studies on Anticoagulated Patients

- SPAF (Ann Int Med 1998)
  - TEE evaluation 382 hi risk AF patients
  - 63% SEC (20% dense)
  - Median INR 2.3
  - Stroke rate: Faint SEC 2.8%, Dense SEC 4.5%

- Bonn Study (JACC 2005)
  - Serial TEE, neurology and MRI exams
  - 128 permanent AF patients: dense SEC
  - On warfarin with mean INR 2.3 (31% suboptimal)
  - Thromboembolic events 23%
    - 3pts (2%) cerebral embolism with neuro deficits
    - 8pts (6%) died due to embolic events
    - 19pts (15%) silent embolism on MRI
SEC developing into thrombus

despite OAC

Post MitraClip for severe MR

6 month f/u

pre Watchman
Prognostic Significance of Left Atrial Appendage “Sludge” in Patients with Atrial Fibrillation: A New Transesophageal Echocardiographic Thromboembolic Risk Factor

- 340 AF pts pre CVD or PV isolation
- Evaluation with TTE and TEE
  - SEC 84pts (25%)
  - “sludge” 47 pts (14%)
  - Thrombus 62pts (18%)
  - Controls 147pts (43%)
- Outcome measures (F/U 6.7 ± 3.7yrs)
  - Thromboembolic events (CVA, TIA, other emboli)
  - All-cause mortality

JASE 2014:27:1176
Rates of Thromboembolism and All-Cause Mortality

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Control</th>
<th>SEC</th>
<th>Sludge</th>
<th>thrombus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>40/147(27%)</td>
<td>15/84(18%)</td>
<td>27/47(57%)</td>
<td>39/65(63%)</td>
</tr>
<tr>
<td>Thromboembolic Event</td>
<td>10/137(7%)</td>
<td>9/78(12%)</td>
<td>11/44(25%)</td>
<td>11/55(20%)</td>
</tr>
</tbody>
</table>

Elderly male chronic AF with AS post TAVR

At time of TAVR implant 1 month post TAVR
86 y/o female pre Watchman implant
Chr AF, Hx GI bleedng, frail with falling episodes

Other imaging modalities may be helpful....
### TABLE 4  Comparison of the Different Imaging Modalities for Assessment of the LAA

<table>
<thead>
<tr>
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<th>TEE</th>
<th>MDCT</th>
<th>CMR</th>
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</thead>
<tbody>
<tr>
<td>Sensitivity/specificity for LAA thrombi detection</td>
<td>92%-100%/98%-99%</td>
<td>96%/92%</td>
<td>67%/44%</td>
</tr>
<tr>
<td>Spatial resolution</td>
<td>0.2-0.5 mm</td>
<td>0.4 mm</td>
<td>1-2 mm</td>
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<tr>
<td>Temporal resolution</td>
<td>20-33 ms</td>
<td>70-105 ms</td>
<td>30-50 ms</td>
</tr>
<tr>
<td>3D volume rendering</td>
<td>Yes (with 3D)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Contrast required</td>
<td>No*</td>
<td>Yes</td>
<td>No*</td>
</tr>
<tr>
<td>Ionizing radiation</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Special considerations</td>
<td>Widely available, provides real-time assessment Semi-invasive</td>
<td>Noninvasive, dynamic assessment of LA function Cannot be performed real-time during procedures</td>
<td>Noninvasive, cannot be performed real-time during procedures Limited availability Cannot be performed in patients with pacemakers</td>
</tr>
</tbody>
</table>

**CT**

Radiology 2009;251:683
TABLE 1 LA and LAA Imaging-Based Variables to Predict Stroke

<table>
<thead>
<tr>
<th>Conventional echocardiography</th>
<th>LA dilation (M-mode)</th>
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<tbody>
<tr>
<td></td>
<td>Spontaneous echo contrast</td>
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<tr>
<td></td>
<td>LAA thrombus</td>
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<td></td>
<td>LAA peak velocity &lt;20 cm/s (pulsed-wave Doppler)</td>
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<tr>
<td></td>
<td>LAA non-chicken wing shape</td>
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<tr>
<td>Speckle tracking echocardiography</td>
<td>LA longitudinal strain (reservoir function)</td>
</tr>
<tr>
<td>Cardiac magnetic resonance</td>
<td>LA volume</td>
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<tr>
<td></td>
<td>LA longitudinal strain (reservoir function, tissue tracking CMR)</td>
</tr>
<tr>
<td></td>
<td>LA fibrosis (LGE-CMR)</td>
</tr>
<tr>
<td></td>
<td>LA flow (4D-CMR)</td>
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<tr>
<td></td>
<td>LAA non-chicken wing shape</td>
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<tr>
<td>Multidetector row computed tomography</td>
<td>LAA non-chicken wing shape</td>
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</tbody>
</table>

4D = 4-dimensional; CMR = cardiac magnetic resonance; LA = left atrium; LAA = left atrial appendage; LGE = late gadolinium enhancement.
Current risk stratification in AF is based on clinical scores
  - Do not include LA remodeling and function

Multimodality imaging provides a comprehensive evaluation that includes parameters of risk before thrombus formation

OAC effective, but not perfect, in reducing stroke risk in those with high clinical risk scores

In patients at lower risk, use of other parameters should be considered (eg strain)