Lapland, Sarek National Park, Sweden
Recommendations for chamber quantification


In preparation: “focussed update”
Relevant developments for update

- new normative and prognostic data emerging, e.g. left atrial size

- obsolescence of M-mode

- increased and new use for particular measurements, e.g. aortic annulus for TAVI/TAVR, left atrial size for diastolic function and risk assessment

- new technologies: harmonic imaging, simultaneous biplane imaging, 3D imaging, tissue Doppler and strain imaging
Left ventricle

Size:

• 2D-guided measurements preferred over M-mode
• caliper on “interface between cavity and wall” (no “leading edge”)
• volumes/EF from biplane mod. Simpson’s rule (or, if apex not well imaged, area-length)
• nomograms for BSA, gender, age, race
• no “mild, moderate, severe” abnormality classification (just mean ± 2SD)
• 3D volumes: not yet
new normal for EF: 63 ± 5% (53 – 73)
Alternative for LV volume calculation:
Area length method \( V = A \times L \times \frac{5}{6} \)
Left ventricle

Global function:

• EF, fractional shortening (in concentric hypertrophy, midwall FS recommended)

• **Global longitudinal strain** (heterogeneous normal values)

Regional function:

• 16 or 18 segment models preferred over 17-segment model

• wall motion score: **no extra category for aneurysm**

• **regional longitudinal strain**: (heterogeneous normal values)

• new **post-systolic shortening** (after aortic valve closure) in ischemic heart disease is a sign of ischemia
**Left ventricular segmentation: 16/17/18 segments**

- **16 segment model**

---

**LV Segmentation**
Segmental analysis of LV walls based on schematic views, in a parasternal short and apical long-axis orientation.

1. **Four Chamber**
   - Apical cap
   - Mid interoseptum
   - Basal interoseptum

2. **Two Chamber**
   - Apical cap
   - Mid anterior
   - Basal anterior

3. **Long Axis**
   - Apical cap
   - Mid inferolateral
   - Basal inferolateral

4. **Base**
   - Anterior
   - Antero-septum
   - Inferior

5. **Mid**
   - Anterior
   - Antero-septum
   - Inferior

6. **Apex**
   - Anterior
   - Septal
   - Inferior
global (long.) strain -9%
Post-systolic shortening

“normal” PSS

pathologic PSS > 30%

Voigt JASE 2003;16:415
Right ventricle

The RV dimensions are … best estimated from a RV-focused apical 4-chamber view....indexing should be considered only at the extremes of BSA. …a diameter >42 mm at the base …indicates RV dilatation. Similarly, longitudinal dimension >86 mm indicates RV enlargement.

The “RV focussed” view (LV apex at center, maximal RV diameter)
Overlap in RV size between athletes and ARVC

Furthermore, 28% of the population had values greater than the proposed "major criteria" for ARVC.
Recommended functional RV parameters:

• TAPSE (≥ 17 mm) or

• fractional area shortening (≥ 35%) or

• S’ or (≥ 9.5 cm/s) or

• 3D ejection fraction (≥ 45%) (+ estimate of systolic pulmonary pressure)
Aortic root diameter

- where to measure?
  Sinus Valsalvae, tubular ascending aorta?
- how to measure? leading, trailing edge?
- when to measure? diastole, systole?
Simultaneous imaging in orthogonal planes ("x-plane")
off-axis images of aortic annulus/valve/root

- maximize aortic diameter
- look for central valve closure
- look for $\varnothing$ perpendicular to LAX
- from and to cavity/wall interface
- measure annulus in systole, other aortic diameters in diastole
**Left atrial size**

“The recommended linear dimension is the LA antero-posterior measurement ... using M-mode or preferably 2D imaging... AP linear dimension should not be used as the sole measure of LA size.”

Recommended:
- mod.biplane Simpson rule or area-length
- “single plane LA volumes ... can be used as a simpler tool for measuring the LA volume in the majority of patients
**Left atrial size**

Present upper normal cut-off: $\leq 32 \text{ mL/m}^2$

**Table 1. Echocardiographic Determination of LAV in Normal Subjects (n = 124)**

<table>
<thead>
<tr>
<th>Total*</th>
<th>Cutoff†</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>2D LAVi max, ml/m²</td>
<td>$24.1 \pm 6.0$</td>
<td>$36$</td>
</tr>
</tbody>
</table>

Wu JACC CV Img 2013, epub

Mean LAVi was $32.2 \pm 9.0 \text{ mL/m}^2$ (range $= 15.8 - 69.9 \text{ mL/m}^2$) in the pooled population and was larger in athletes than in non-athletes ($38.9 \pm 9.6 \text{ mL/m}^2$ vs. $28.4 \pm 5.8 \text{ mL/m}^2$, respectively, $P < 0.0001$).

Nistri EJE 2011;12:826

Final cut-off for LA size will probably be $\geq 36 \text{ mL/m}^2$
Summary

• 2D measurements preferred; border cavity/blood
• GLS and post-systolic shortening introduced for LV function
• RV focussed view emphasized, overlap in size between cardiomyopathy and athletes
• aortic root: biplane adjustment of 2D planes recommended; Ø annulus in systole, other Ø in diastole
• left atrial size: cut-off will increase > 32 mL/m²
• normal values difficult to provide in new 3D and strain due to vendor dependency
Left Atrial Volume = \( \frac{8}{3\pi}[\frac{(A_1)(A_2)}{L}] \)

* \( L \) is the shortest of either the A4C or A2C length
Durchmesser der Aorta
Bedeutung
der Orientierung der Untersuchungsebene

Importance of “double-oblique” vs. axial measurement of aorta for CT

Mendoza Ann Thorac Surg 2011;92:904