Assessment of Right Heart in Adults
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Objectives
- Understand the Importance of the Right Heart function
- Review the ASE Guidelines for Assessment of the Right Heart in Adults
- Review the imaging views of the right heart
- Review quantitative measures of right heart function

The Right Heart - Why is it Important?
- Normal
  - Physiology/Function
- Disease States
  - Volume Overload
  - Pressure Overload
  - Ischemic Dysfunction
Qualitative vs. Quantitative Imaging

Overview of the Guidelines

- Guidelines for the Echocardiographic Assessment of the Right Heart in Adults: A Report from the American Society of Echocardiography
  - J Am Soc Echocardiogr 2010;23:685-713
  - July 2010

Purpose of the Guidelines

- Describe the acoustic windows and views required for optimal evaluation
- Describe parameters required in routine and directed studies and the views to obtain these parameters
- Critically assess available data and the advantages and disadvantages of each measure
- Recommend which right-sided measures should be included in report
- Provide reference values for right-sided measures
Right Atrium

- **Recommendation**
  - Images adequate for RA areas estimation should be obtained in patients undergoing evaluation for RV or LV dysfunction.
  - Upper reference limits are 4.4 cm (minor-axis) and 5.3 cm (major-axis).
  - Because of paucity of data, standardized RA volume data are not currently recommended.
IVC / RA Pressure Assessment

- IVC diameter and IVC collapse most commonly used to assess RA pressure
- Most effective for low or high measurements
- Less discriminatory in middle ranges
- Subcostal view most useful for imaging the IVC
- IVC imaged in long axis
- Sniff and Quiet respiration helpful

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**Source:** Journal of the American Society of Echocardiography 2010; 23:685-713

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**IVC evaluation**

<table>
<thead>
<tr>
<th>IVC Dimension</th>
<th>Collapse</th>
<th>RA Pressure Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 2.1 cm</td>
<td>&gt;50%</td>
<td>3 mm Hg (normal)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>range 0-5 mm Hg</td>
</tr>
<tr>
<td>Intermediate</td>
<td></td>
<td>8 mm Hg</td>
</tr>
<tr>
<td>≥ 2.1 cm</td>
<td>&lt; 50%</td>
<td>15 mm Hg (high)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>range 10-22 mm Hg</td>
</tr>
</tbody>
</table>
Right Ventricular Wall Thickness

- Abnormal RV wall thickness should be reported if present
- Normal cut-off 0.5 cm from PLAX or subcostal view

Recommendation

- If evidence of right-sided heart disease or PH
- RV measurement basal, mid cavity and longitudinal dimensions on a 4-chamber view should be obtained
- RV basal measurement reported for all
- Report should state window from which the measurement was obtained
- Upper reference limit for RV basal dimension is 4.2 cm

RV Fractional Area Change
**Recommendation**

- RV Fractional Area Change
  - 2-Dimensional Fractional Area Change (FAC) is one method of quantitatively estimating RV function
  - Lower reference value for normal RV systolic function is 35%

**RV 3-D Volume**

- Advantages
  - RV volumes and EF may be accurately measured
- Disadvantages:
  - Limited normative data
  - Tend to underestimate MRI-derived RV volumes
  - Limited data in dilated or dysfunctional ventricles

**Recommendation**

- In selected patients with RV dilation or dysfunction, 3D echocardiography using disk summation method may be used to report RV EF
- Lower reference limit of 44% has been obtained from pooled data
- May be reasonable to reserve 3D measurement for serial volume and EF determination
RV Septum Morphology

- RV Pressure Overload
- RV Volume Overload
- RV Pressure and Volume Overload

Recommendation

- Visual assessment of ventricular septal curvature looking for a D-shaped pattern in systole and diastole should be used to help in the diagnosis of RV volume/and/or pressure overload.

- While not diagnostic, if D-shaped septum is present, additional emphasis should be placed on the confirmation as well as determination of etiology of right-sided pressure and/or volume overload.

Hemodynamic Assessment

- Systolic Pulmonary Artery Pressure
- PA Diastolic Pressure
- Mean PA Pressure
- Pulmonary Vascular Resistance
Recommendation

- PA hemodynamics are feasible in most patients
- SPAP should be estimated and reported in all subjects with TR jets
- If patients with PA hypertension or CHF
  - Estimate of PADP should be reported
- If estimated SPAP is > 35 mm HG, stronger scrutiny warranted to determine if PH is present

PA Pressure During Exercise

- It is reasonable to assess for stress-induced PH in patients with dyspnea of unknown etiology and normal resting echocardiography and no evidence of CAD
  - Supine bicycle exercise is preferred
  - Upper limit of 43 mm HG SPAP

Qualitative vs. Quantitative RV Assessment

- Nonvolumetric Assessment of RV Function
  - Global Assessment of RV systolic function
    - RV ejection
  - Regional Assessment of RV systolic function
    - TAPSE or Tricuspid Annular Motion (TAM)
    - Doppler Tissue Imaging
    - Myocardial Acceleration During Isovolumic Contraction
    - Regional RV Strain and Strain Rate
    - Right Ventricular Diastolic Dysfunction
RV dP/dt
- Rate of pressure rise in the ventricle over time
- Time for TR jet to increase in velocity from 1-2 m/s
  - 12 mm Hg increase/time

Recommendation
- Because of the lack of data in normal subjects, RV dP/dt cannot be recommended for routine use
- Can be considered in subjects with suspected RV dysfunction
  - < 400 mm Hg/s normal range

TaPSe
**Recommendation**
- TAPSE should be used routinely as a simple method of estimating RV function
- Lower reference value for impaired RV systolic function is 16 mm

**Tissue Doppler Imaging**
- **Advantages**
  - Simple, reproducible good discriminatory ability
- **Disadvantages**
  - Less reproducible for non-basal segments
  - Angle dependent
  - Less accurate in regional dysfunction states

**Recommendation**
- Interrogation of S’ by pulsed tissue Doppler is a simple and reproducible measure to assess basal RV free wall function
- S’ < 10 cm/s should raise suspicion of abnormal RV function, particularly in younger patient
- Color-coded tissue doppler remains a research tool
Myocardial Acceleration During Isovolumic Contraction

**Advantages**
- Relatively load independent
- Correlates with severity of illness

**Disadvantages**
- Limited normative data available
- Angle dependent
- Varies with heart rate and age

Recommendation

- In studies in patients with conditions affected by RV function, RV IVA may be used
- Should be measured at the lateral tricuspid annulus

- Broad confidence levels around lower limits
  - No reference value can be recommended
Recommendation

- Given very wide confidence intervals, lack of normative data and angle dependency, strain and strain rate remain research tools.

Right Ventricular Diastolic Dysfunction

- RV diastolic dysfunction has been recognized in acute and chronic conditions.

Recommendation

- Measurement of RV diastolic function should be considered in patients with suspected RV impairment.
  - Transtricuspid E/A ratio
  - E/E'
  - Ra SIZE
RV Diastolic Function Grading

<table>
<thead>
<tr>
<th>Decel time</th>
<th>E/A</th>
<th>E/E'</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 120 ms</td>
<td>&gt; 0.8</td>
<td>&lt; 6</td>
<td>Normal</td>
</tr>
<tr>
<td>&lt; 120 ms</td>
<td>&lt; 0.8</td>
<td>&gt; 6</td>
<td>Impaired relaxation</td>
</tr>
<tr>
<td>0.8-2.1</td>
<td>0.8-2.1</td>
<td>&gt; 6</td>
<td>Pseudonormal</td>
</tr>
<tr>
<td>&gt; 120 ms</td>
<td>&gt; 2.1</td>
<td></td>
<td>Restrictive filling</td>
</tr>
</tbody>
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Summary

- The right heart is more than just a conduit
- Quantitative approach for assessment of RV size and function will help standardize assessment of the right heart across laboratories
- ASE Guideline document provides consistent recommendation for views and normal reference values as available
- Consistent evaluation will help establish echo role in establishing diagnosis and allowing improved clinical follow-up