Evaluation of the Right Ventricle

Michael H. Picard, M.D.
Massachusetts General Hospital
Harvard Medical School
No disclosures

Disclosures

• none

The RV

• Important role in morbidity and mortality in patients with cardiopulmonary disease
• Important marker of prognosis in many diseases
  – Including post MI ventricular septal rupture, many congenital heart diseases, pulmonary embolism, some cardiomyopathies
• Often forgotten during echocardiographic assessments of cardiac function
RV shape is complex and composed of:
1) smooth muscular inflow (body)
2) outflow
3) trabecular apical region
cannot image all 3 regions in 1 2D imaging plane

Why quantify the RV rather than just subjectively assess it?

• Improve accuracy and reduce variability
  – Compared to subjective assessment
  • More sensitive diagnosis of RV pathology
• Objective comparison of serial exams
  – Assessing evolution (or lack of evolution) of disease
• For prognosis and decisions about therapy
  – PE treatment, PE prognosis
  – Determinant of risk in some conditions
Right heart assessment by echo

- RV size
- RA size
- RV function – at least 1 of:
  - FAC
  - S’
  - TAPSE
  - +/- RV MPI
- RVSP
- RA pressure
  - IVC size and collapse
- See ASE guidelines for normal values

Comprehensive Imaging of the RV: 14 views!

Rudski et al, JASE 2010;23:685-713

Comprehensive imaging of RV: 14 views!

Rudski et al, JASE 2010;23:685-713
RV size

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>RV end diastolic diameter (cm)</td>
<td>3.5</td>
<td>0.5</td>
<td>2.2</td>
<td>5.5</td>
</tr>
<tr>
<td>RV end systolic diameter (cm)</td>
<td>2.5</td>
<td>0.2</td>
<td>1.8</td>
<td>4.0</td>
</tr>
<tr>
<td>RV cavity area (cm²)</td>
<td>15</td>
<td>5</td>
<td>5</td>
<td>35</td>
</tr>
<tr>
<td>RV end systolic volume indexed</td>
<td>100</td>
<td>15</td>
<td>70</td>
<td>200</td>
</tr>
<tr>
<td>RV end diastolic volume indexed</td>
<td>150</td>
<td>25</td>
<td>100</td>
<td>300</td>
</tr>
<tr>
<td>RV end systolic mass indexed</td>
<td>1.5</td>
<td>0.3</td>
<td>0.8</td>
<td>2.5</td>
</tr>
<tr>
<td>RV end diastolic mass indexed</td>
<td>2.0</td>
<td>0.5</td>
<td>1.0</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Measure the RV at end diastole from apical 4 chamber image demonstrating the maximum diameter of the RV without foreshortening.

RV dimensions – PLAX less variability

Rudski et al, JASE 2010;23:685-713
Normal RV wall thickness < 5 mm

Rudski et al., JASE 2010;23:685-713

Right ventricular function

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>Range</th>
<th>Systolic function</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAPSE (mm)</td>
<td>18.2</td>
<td>16.1-20.5</td>
<td>&lt;1.6</td>
</tr>
<tr>
<td>Pseudoejection velocity of the annulus (cm/s)</td>
<td>&lt;10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Echocardiographic MPI</td>
<td>&gt;0.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAC %</td>
<td>&gt;58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diastolic function</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E/A ratio</td>
<td>&lt;0.8 or &lt;2.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E/E ratio</td>
<td>&lt;6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deceleration time (ms)</td>
<td>&lt;120</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rudski et al., JASE 2010;23:685-713

Fractional area change

\[
\text{Normal > 35} \%
\]

Rudski et al. JASE 2010;23:685-713
Tricuspid Annular Plane Systolic Excursion (TAPSE)

TAPSE > 16 mm = normal

Kaul S et al, Am Heart J 1984;107:526-531

Tissue Doppler of TV annulus

S’ > 10 cm/s = normal

Rudski et al, JASE 2010;23:685-713
Quantitation of global systolic function: Ejection phase indices

Doppler total ejection isovolume index - Tei index
- Failing ventricle, shorter ET so larger the MPI worse the function

- Doppler measure
- No geometric assumptions
- Less dependent on load
- Requires accurate IVRT, ET, IVCT
- Pseudonormalization
  - Elevated atrial pressure shortens IVRT so MPI decreased

RV Myocardial Performance Index (RVMPI)

Pulsed Doppler Method

TV closure to opening time (TCO) = IVCT + ET + IVRT

TCO - RVOT ET = IVCT + IVRT

MPI = \frac{TCO - ET}{ET}

RV MPI pw Doppler method < 0.4 = normal

Rudski et al. JASE 2010;23:685-713
RV Myocardial Performance Index (RV MPI)

Tissue Doppler Method

S’ duration = RVET
End of A’ to start of E’ = TCO

MPI = (TCO – ET) / ET

RVMPI TDI method < 0.55 = normal

Rudski et al, JASE 2010;23:685-713

Measure IVC 0.5 – 3 cm from RA

Caution:
even in normal RA pressure
IVC larger in athletes
pos pressure ventilators - IVC larger + may not collapse

Rudski et al, JASE 2010;23:685-713
IVC to assess RA pressure

IVC (mm) | Respiratory Change | RA pressure (mm Hg)
---------|-------------------|-------------------
Normal ≤ 21 | Total collapse | < 5
Normal ≤ 21 | > 50% | 5
Normal ≤ 21 | < 50% | 10
Dilated > 21 | > 50% | 10
Dilated > 21 | < 50% | 15
Dilated > 21 | No change | ≥ 20

Simple method to calculate RVSP

Currie PJ et al, Continuous-wave Doppler determination of RV pressure: a simultaneous Doppler-catheterization study in 127 patients. JACC 1985;6:750-756

RV SP = 4V² + ??

V = peak systolic velocity on TR CW Doppler

Case examples of RV dysfunction
McConnell’s Sign

Ebstein’s Anomaly

RA and RV overload from severe TR from Carcinoid Syndrome
SG – 65 M w rheumatic MS, s/p PMV X 2 and MVR
TTE – MV mean gradient 8 mm Hg, nl LV, RVSP 61 mm Hg, mild systolic flattening of IVS
is there RV dysfunction?

TAPSE = 9 mm
Abnl < 16

S'TDI = 9 cm/sec
Abnl < 10

MPI = (0.43 - 0.26) / 0.26 = 0.65
abnl > 0.55
RT 68 M w ARVC + recurrent VT s/p VT ablation X 3

CMR

RV prominently enlarged with diffuse global hypokinesis and dyskinetic segments, constituting a major criterion for ARVC.

Extensive regional wall thinning with prominent transmural scar, constituting another major criterion for ARVC.

TTE to assess if RV function worsening

2006

2010
FAC = 35.2 – 24.1 = 32% 
35.2

FAC = 36.2 – 24.6 = 32% 
36.2