Echocardiographic and MR investigation

What are the signs of ventricular dysfunction?

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“Frequent PVCs in structurally normal heart”

1. The role of imaging in exclusion of structural heart disease

2. The role of imaging in functional evaluation
“Frequent PVCs in structurally normal heart”

- Imaging is very important step of evaluation
- First imaging tool is echocardiography
  - Easy achievable
  - Most children have good acoustic windows
  - Transthoracic echo generally gives us sufficient information
Echocardiographic assessment

- Exclusion of structural heart disease
  - Hemodynamically significant CHD
  - Cardiomyopathies
    - ARVC
    - Hypertrophic
    - Dilated
    - Noncompaction
  - Valvular lesions
  - Coronary artery abnormalities
  - Cardiac tumors
Echocardiographic evaluation

- Chamber sizes, wall thicknesses
  - LVEDD
  - RVOT (PLAX, PSAX)
- Quantitation of left ventricular systolic function
  - FS %
  - EF %
- Quantitation of right ventricular systolic function
  - TAPSE
  - FAC
- Measurement of diastolic function parameters
- Regional wall motion abnormalities
  - akinesia, dyskinesia or aneurysm
Underlying cardiac pathology
Structural or not

- Positive family history

- Symptoms, particularly exercise induced syncope/presyncope, chest pain

- Complex ventricular arrhythmias
  - Multiform PVC
  - NSVT/SVT
  - Polymorphic, bidirectional VT
Myocarditis

• “Occult” myocarditis
  • there is no demonstrable structural pathology
  • there is no functional abnormality by echocardiography

• The possibility of myocarditis
  • acutely symptomatic patients

• Complex ventricular arrhythmias
  • Multiform PVCs
  • NSVT/VT
Conclusions. These results provide evidence that approximately 50% of children with abnormal ventricular ectopic rhythm but a structurally normal heart may have subclinical cardiomyopathy or unsuspected myocarditis.

(J Am Coll Cardiol 1992;20:359–62)

Conclusions. Complex ventricular arrhythmias persist after apparent resolution of occult myocarditis in children. Although these arrhythmias are easier to control after such resolution, the patients may require long-term antiarrhythmic therapy.

(J Am Coll Cardiol 1994;24:780–3)
Cardiac MRI

• In suspicion of
  • Myocarditis (ongoing or past)
  • ARVC
  • Doubtful cases

MRI should be a part of evaluation

• Cardiac chamber dimensions, wall thicknesses
• Ventricular diastolic and systolic volumes
• EF of both ventricles
• Segmental wall motion abnormalities
• The presence and extent of myocardial edema/inflammation
• Areas of fibrosis (LGE)
Prevalence and clinical relevance of the morphological substrate of ventricular arrhythmias in patients without known cardiac conditions detected by cardiovascular MR

Inclusion (n=76):
- 39 male, 37 female
- premature ventricular beats > Iown II (n=30)
- ventricular tachycardia (n=34)
- ventricular flutter (n=1)
- ventricular fibrillation (n=7)

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>No. of patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dilated cardiomyopathy</td>
<td>3 (3.9%)</td>
</tr>
<tr>
<td>Hypertrophic cardiomyopathy</td>
<td>1 (1.3%)</td>
</tr>
<tr>
<td>CMR criteria for ARVC</td>
<td>3 (3.9%)</td>
</tr>
<tr>
<td>Post-myocarditis scar</td>
<td>5 (6.6%)</td>
</tr>
<tr>
<td>Post-myocardial infarction scar</td>
<td>2 (2.6%)</td>
</tr>
<tr>
<td>Myocarditis</td>
<td>6 (7.9%)</td>
</tr>
<tr>
<td>Total</td>
<td>20 (26.3%)</td>
</tr>
</tbody>
</table>
Arrhythmogenic right ventricular cardiomyopathy
ARVC

Diagnosis of Arrhythmogenic Right Ventricular Cardiomyopathy/Dysplasia
Proposed Modification of the Task Force Criteria
(Circulation. 2010;121:1533-1541.)

By 2D echo:
- Regional RV akinesia, dyskinesia, or aneurysm
- and 1 of the following (end diastole):
  - PLAX RVOT $\geq$ 32 mm (corrected for body size [PLAX/BSA] $\geq$ 19 mm/m$^2$)
  - PSAX RVOT $\geq$ 36 mm (corrected for body size [PSAX/BSA] $\geq$ 21 mm/m$^2$)
  - or fractional area change $\leq$ 33%
Diagnosis of Arrhythmogenic Right Ventricular Cardiomyopathy/Dysplasia

Proposed Modification of the Task Force Criteria

(Circulation. 2010;121:1533-1541.)

By MRI:
- Regional RV akinesia or dyskinesia or dyssynchronous RV contraction
- and 1 of the following:
  - Ratio of RV end-diastolic volume to BSA ≥110 mL/m² (male) or ≥100 mL/m² (female)
  - or RV ejection fraction ≤40%
Fat infiltration

Hypertrabeculation
Late gadolinium enhancement
Functional Evaluation
Ventricular dysfunction

- Adults with high PVC burden can develop left ventricular dilation, dysfunction consistent with a cardiomyopathy.
- It is reversible with medical therapy or radiofrequency ablation.

### Table 1: PVC burden associated with LV dysfunction

<table>
<thead>
<tr>
<th>Study</th>
<th>n</th>
<th>%LVd</th>
<th>%VEs LVd</th>
<th>%VEs normal LV</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ban et al.</td>
<td>127 (28 LVd)</td>
<td>22%</td>
<td>31 ± 11%</td>
<td>22 ± 10%</td>
<td>0.001</td>
</tr>
<tr>
<td>Deyell et al.</td>
<td>90 (24 LVd)</td>
<td>27%</td>
<td>32 ± 12%</td>
<td>27 ± 12%</td>
<td>0.077</td>
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<tr>
<td>Munoz et al.</td>
<td>70 (LVd 17)</td>
<td>24%</td>
<td>29 ± 15%</td>
<td>17 ± 14%</td>
<td>0.004</td>
</tr>
<tr>
<td>Olgun et al.</td>
<td>51 (21 LVd)</td>
<td>41%</td>
<td>30 ± 11%</td>
<td>14 ± 15%</td>
<td>0.0001</td>
</tr>
<tr>
<td>Hasdemir et al.</td>
<td>249 (17 LVd)</td>
<td>7%</td>
<td>29 ± 9%</td>
<td>8 ± 7%</td>
<td>0.001</td>
</tr>
<tr>
<td>Baman et al.</td>
<td>174 (57 LVd)</td>
<td>33%</td>
<td>33 ± 13%</td>
<td>13 ± 12%</td>
<td>0.0001</td>
</tr>
<tr>
<td>Kanei et al.</td>
<td>108 (21 LVd)</td>
<td>19%</td>
<td>13 ± 11%</td>
<td>7 ± 9%</td>
<td>0.004</td>
</tr>
</tbody>
</table>

Europace (2014) 16, 1257–1283
Ventricular dysfunction

Usefulness of Ventricular Premature Complexes in Asymptomatic Patients ≤21 Years as Predictors of Poor Left Ventricular Function

Karine Guerrier, DO, MPH*, Jeffrey B. Anderson, MD, MPH, Richard J. Czosek, MD, Wayne A. Mays, MS, Christopher Statile, MD, Timothy K. Knilans, MD, and David S. Spar, MD

Am J Cardiol 2015;115:652e655

• 22/123 patients (18%) had VPC burden >24%
• none of them had decreased LV FS
Frequent Ventricular Premature Beats in Children With a Structurally Normal Heart: A Cause for Reversible Left Ventricular Dysfunction?

Bahram Kakavand · Hubert O. Ballard · Thomas G. Disessa


- **4/28 children** developed LV systolic dysfunction and dilation
- All 4 CMP resolved, with medicine in 2, spontaneously in 2
- All had > 20% VPC burden
Ventricular dysfunction

Premature ventricular contraction-induced cardiomyopathy in children

Zebulon Z. Spector, Stephen P. Seslar

Cardiology in the Young (2016), 26, 711–717

• 36 children with > 20% PVC burden

• 7/36 (19 %) patients with LV dysfunction (FS < 28)

• PVC burden 34,7+6,3% vs 27.2 + 5,1%

• None of them symptomatic
Ventricular dysfunction

Left ventricular dysfunction is associated with frequent premature ventricular complexes and asymptomatic ventricular tachycardia in children

R.A. Bertels¹,²*, L.M. Harteveld¹,², L.H. Filippini¹,³, S.A. Clur¹,⁴, and N.A. Blom¹,²,⁴

• 6/72 patients showed LV dysfunction at presentation (2 symptomatic)

• Patients with LV dysfunction had
  • higher PVC burden (47+16 vs. 16+11%)
  • higher prevalence of VT 5 (83%) vs. 27 (41%) and sustained ventricular tachycardia (sVT) 3 (50%) vs. 4 (6%)
  • higher number of couplets [6 (100%) vs. 34 (52%)]
Difficulties in assessing functions
Difficulties in assessing functions
Conclusion

• Echocardiography is an important imaging tool
  • to exclude structural heart disease
  • functional assessment

• Myocarditis and ARVC may have subtle/no signs in echo

• In doubtful cases MRI with gadolinum gives invaluable information
  • structure, functions and tissue characteristics