PAEDIATRIC ECG

Dimosthenis Avramidis, MD.
Consultant Mitera Children’s Hospital Athens Greece
S. Associate 1st Cardiology Dpt Evangelismos Hospital Athens Greece
5 y/o with sinus tach
ECG changes during the first year of life reflect the switch from fetal to infant circulation, changes in SVR, and the increasing muscle mass of the LV.

The size of the ventricles changes as the infant grows into childhood and adulthood.

The RV is larger and thicker at birth because of the physiologic stresses on it during fetal development.

By approximately 1 month of age, the LV will be slightly larger.

By 6 months of age, the LV is twice the size of the RV, and by adolescence it is 2.5 times the size.
Age Related Normal Findings

- Tables exist that include age based normal ranges for heart rate, QRS axis, PR and QRS intervals, and R and S wave amplitudes.
- After infancy, changes become more subtle and gradual as the ECG becomes more like that of an adult.

<table>
<thead>
<tr>
<th>Age</th>
<th>PR interval (ms)</th>
<th>QRS duration (ms)</th>
<th>Lead V1</th>
<th>Lead V6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth</td>
<td>80-160</td>
<td>&lt;75</td>
<td>5-26 (1-23)</td>
<td>0-12 (0-10)</td>
</tr>
<tr>
<td>6 months</td>
<td>70-150</td>
<td>&lt;75</td>
<td>3-20 (1-17)</td>
<td>6-22 (0-10)</td>
</tr>
<tr>
<td>1 year</td>
<td>70-150</td>
<td>&lt;75</td>
<td>2-20 (1-20)</td>
<td>6-23 (0-7)</td>
</tr>
<tr>
<td>5 years</td>
<td>80-160</td>
<td>&lt;80</td>
<td>1-16 (2-22)</td>
<td>8-25 (0-5)</td>
</tr>
<tr>
<td>10 years</td>
<td>90-170</td>
<td>&lt;85</td>
<td>1-12 (3-25)</td>
<td>9-26 (0-4)</td>
</tr>
</tbody>
</table>
The P Wave

• Best seen in leads II and V1
• P wave amplitude does not change significantly during childhood
• Amplitudes of 0.25 mV should be regarded as approaching the upper limit of normal
The QRS Complex

- QRS complex duration is shorter, presumable because of decreased muscle mass
- QRS complexes > 0.08 sec in patients < 8 years is pathologic
- In older children and adolescence a QRS duration > 0.09 sec is also pathologic
The T Wave

• The T waves are frequently upright throughout the precordium in the first week of life.
• Thereafter, T waves in V1-V3 invert and remain inverted from the newborn period until 8 years of age.
• This is called the “juvenile T wave pattern”, and can sometimes persist into adolescence.
• Upright T waves in the right precordial leads in children can indicate right ventricular hypertrophy.
3 day old & 12 y/o
QRS Axis and Ventricular Dominance

• At birth, the axis is markedly rightward (+60 - +160), the R/S ratio is high in V1 and V2 (large precordial R waves), and low in V5 and V6
• As the LV muscle mass grows and becomes dominant the axis gradually shifts (+10 - +100) by 1 year of age, and the R wave amplitude decreases in V1 and V2 and increases in V5 and V6
2 year old with syncope and VT
Intervals

- PR and QRS durations are relatively short from birth to age 1 and gradually lengthen during childhood; corrected QT (QTc) should be calculated on all pediatric ECGs.
- After that, any QTc above 0.44 sec is abnormal.
- Other features of long QT syndrome include notched T waves, abnormal U waves, relative bradycardia and T wave alternans.
Other

- **Heart rate**
  - Average heart rate peaks at second month of life, then gradually decreases
  - Resting HRs start at 140 bpm at birth, fall to 120 bpm at 1 year, 100 bpm at 5 years, and adult ranges by 10 years

- **Q waves**
  - Can be seen normally in the inferior or lateral leads
  - Q waves in other leads are pathologic (eg, anomalous left coronary artery)
  - Q waves of 0.6-0.8 mV are normal within 6 mo to 3 years of age
Interpretation?
Atrial Enlargement

- RAE is diagnosed in the presence of a peaked tall P wave in II
- In the first 6 months, the P wave must be >3 mm to be pathologic; then >2 mm is abN
- LAE can be diagnosed with a biphasic P wave in V1 with a terminal inferior component
- The finding of a notched P wave in II can be a normal variant in 25% of pediatric ECGs
Interpretation?
RVH

- Large R wave in V1 and large S wave in V6
- Upright T wave in V1-V3
- RAD
- Persistent pattern of RV dominance
- Right Ventricular Hypertrophy

- Diagnosis depends on age adjusted values for R wave and S wave amplitudes
- A qR complex or rSR’ pattern in V1 can also be seen
- Upright T waves in the right precordial leads, RAD, and complete reversal of adult precordial pattern of R and S waves all suggest RVH
Interpretation?
LVH

- R wave > 98\textsuperscript{th} percentile in V6 and S wave > 98\textsuperscript{th} percentile in V1
- LV “strain” pattern in V5 and V6 or deep Q waves in left precordial leads
- “Adult” precordial R wave progression in the neonate
Conduction Abnormalities

• Bundle branch blocks are diagnosed as they would be in adults; RBBB occurs most commonly after repair of congenital heart defects and LBBB is very rare.
• First degree AV block and Mobitz type 1 (Wenckebach) can be a normal variant in 10% of kids.
• Complete AV block is usually congenital or secondary to surgery.
13 y/o with palpitations
22 day old with poor feeding
12 y/o with chest pain
Tachydysrhythmias

- **SVT**
  - Most common dysrhythmia in children
  - Occurs in between 1/250 to 1/1000 patients
  - ECG shows narrow complex regular tachycardia with rate between 150-300; P waves may or may not be evident
  - Peak age of onset is at 2 months of age (40%)
  - Most are due to an AV reentrant mechanism

- **WPW**
  - May exhibit signs of pre-excitation on NSR
  - Can develop sustained tachcardias with accessory pathway conduction resulting in either narrow complex (orthodromic) tachycardia or wide complex (antidromic) tachycardia
  - The most common dyrhythmia is PSVT (AVRT)
17 y/o routine ECG
Normal Variants

• Sinus arrhythmia
  • Can be quite marked
  • Slows on expiration and speeds up on inspiration

• Extrasystoles
  • Can be atrial or ventricular and are usually benign in the context of a structurally normal heart; typically monomorphic and associated with slower heart rates
  • Abolish with excercise

Common variations in rhythm which may be normal
- Pronounced sinus arrhythmia
- Short sinus pauses < 1.8 seconds
- First degree atrioventricular block
- Mobitz type 1 second degree atrioventricular block
- Junctional rhythm
- Ventricular or supraventricular extrasystole
In Summary

• Consider the age of the child, and the cardiac forces that may be dominant
• Use a structured approach and assess morphology, axis, and intervals in the context of age related normals
• Evaluate for the presence of structural disease
• Remember the “normal variants”
To Calculate Heart Rate:
Count the number of “R” waves in 6 seconds.
(6 large blocks X 10 = 1 min rate)
9 years old boy preparticipation screening
EXERCISE TEST / ECG Strips

MITERA PEDIATRIC CARDIOLOGY DEPARTMENT

Patient ID: 539
10/02/2011
10:49

137 bpm

RECOVERY
1:28

BRUCE
0.0 km/h
0.0 %
8 years old boy preparticipation screening
14 years old girl with palpitations
9 years old boy preparticipation screening
13 years old boy normal ECHO
14 years old girl palpitations
8 years old boy syncope after exercise
15 years old girl aborted SCD
15 years old boy with palpitations during exertion
AFL with aberration
SVT with aberration
VT