Cardiac Evaluation of the Adolescent: The Examination

murmurlab.org

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An auscultation tour

Introduction

We will be using infrared stethoscopes for part of this presentation. To hear the heart sounds, simply place the earpieces in your ears normally and make sure the front of the infrared receiver (with the writing on it) is facing away from your chest. Turn the unit on and adjust the volume using the switch on the side. When you are not listening to heart sounds, remove the earpieces from your ears to prevent "ear fatigue."

The heart sounds and murmurs we will be listening to are from our murmurlab.org website which features the Cardiac Auscultatory Recording Database (CARD), an on-going project in the Division of Pediatric Cardiology at Hopkins to collect and digitize actual patient cardiac examinations for teaching and research. The database is accessible to any interested healthcare professional or trainee via the Internet using an interactive, multimedia program that we will use and discuss today.

After a brief introduction, our tour will begin with a normal example, then a few generic systolic murmurs of increasing intensity. This will give you a chance to get used to the electronic sounds and to get a feel for the relative intensities of murmurs in the database that span the scale from grade 1 (just audible) to grade 6 (heard with the stethoscope head off the chest). Adjust the volume on your unit so that you can just hear the grade 1 murmur, but the grade 6 murmur does not sound distorted.

But first, let’s briefly look at some reasons for reviewing and refining our auscultation skills…
Evaluation of heart murmurs

ACC/AHA 2006 Guidelines for the Management of Patients With Valvular Heart Disease (Circulation. 2006 Aug 1;114(5):e84-231):

Figure 2. Strategy for evaluating heart murmurs. *If an electrocardiogram or chest X-ray has been obtained and is abnormal, echocardiography is indicated.

Consensus statement from 2003 ACC/AHA Practice Guidelines¹:

"As valuable as echocardiography may be, the basic cardiovascular evaluation, including history, physical examination and ECG, is still the most appropriate method to screen for cardiac disease and will establish many clinical diagnoses."

What happens when patients are referred because of a murmur?²

Of 222 consecutive patients referred to JHH for evaluation of a murmur (ages 2d-18y, median 1.9y), only 1/3 had heart disease:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>30%</td>
<td>VSD</td>
</tr>
<tr>
<td>12%</td>
<td>Pulmonary stenosis</td>
</tr>
<tr>
<td>8%</td>
<td>ASD</td>
</tr>
<tr>
<td>&lt;8% (each)</td>
<td>MVP, MR, PDA, AS, TOF, Bicuspid AV, Coarctation</td>
</tr>
</tbody>
</table>

2/3 had an innocent murmur and no heart disease:
66%: Still's murmur
24%: Pulmonary ejection systolic ("flow") murmur
17%: Venous hum
9%: Physiologic peripheral pulmonic stenosis
2%: Carotid bruit
(17% had more than one innocent murmur)

*Clinical assessment by the cardiologist was able to predict pathology with 92% sensitivity, 94% specificity.

Murmurs in the neonate are less common and more likely to be pathologic\(^{3,4}\)

116 neonates (out of 7296 live births, 12h to 14 days old, had a murmur that persisted for >24h (1.6%)

84% had heart disease:

<table>
<thead>
<tr>
<th>%</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>39%</td>
<td>VSD</td>
</tr>
<tr>
<td>15%</td>
<td>PDA (more common in prematures)</td>
</tr>
<tr>
<td>15%</td>
<td>PS</td>
</tr>
<tr>
<td>&lt;15%</td>
<td>ASD, HCM, DCRV, CoA, ToF, TGA/VSD, AVC, DORV, HLHS</td>
</tr>
</tbody>
</table>

6 clinical features are independent predictors of heart disease:\(^2\)

1) Pansystolic murmur (odds ratio [OR], 54.0)
2) Systolic click (OR, 8.35)
3) Grade 3 or higher intensity murmur (OR, 4.84)
4) Murmur best heard at the left upper sternal border (OR, 4.24)
5) Abnormal S2 (OR, 4.09)
6) Harsh murmur quality (OR, 2.37)

*Accurate recognition of these signs may reduce referrals or echocardiography of patients with no heart disease by ~50%.
How well are we training new physicians to use a stethoscope?5,6

Diagnostic accuracy among pediatric residents on a recent auscultation test was only ~33%

*Most commonly missed diagnosis was the innocent pulmonary flow murmur

Test included:

| PS: | Systolic ejection click, systolic ejection murmur (SEM) at LUSB |
| VSD: | Holosystolic murmur at LLNB |
| ASD: | Fixed split S2, SEM, tricuspid rumble |
| AS/AR: | Diastolic decrescendo murmur, SEM at RUSB, Austin-Flint murmur |
| Innocent mur: | Normal S1, S2, SEM at LUSB, S3 |

http://murmurlab.org
The Cardiac Auscultatory Recording Database

**General Information**

- Internet-based clinical skills training.
- Digitized heart sounds and murmurs from over 1200 patients across multiple visits.
- Interactive multimedia with phonocardiograms, ECGs, etc.
- Ability to search for study findings or diagnoses of interest.
- Ability to slow down heart sounds, filter out high or low frequencies, replay and compare to other examples.
- Access to the website is FREE.

**Heartsound Collection**

Heart sounds captured from patients of the Johns Hopkins Hospital, Pediatric Cardiology Outpatient Clinic.

- Sound digitized in synchronous with ECG recording.
- Phonocardiograms depict the sounds heard, for easy identification of murmurs and clicks.
- Clinical Data transcribed from Johns Hopkins Electronic Patient Record while removing identifying patient information.
- Echo reports and EKGs uploaded.

**Gold Standards**

For **Diagnosis** = Echocardiography results.

For **Auscultation** = Auscultation descriptions from pediatric cardiologists transcribed from clinic notes.
Review of Heart sounds

Features of innocent murmurs:

Present in 50-90% of children on at least one exam (much less common in infants)
Systolic ejection pattern
Short duration
Grade 1 or 2 intensity, loudest along LLSB
Does not increase in intensity with Valsalva or in standing position
Normal S2
No other abnormal sounds or murmurs

Types of innocent murmurs:

Still’s murmur

Short, vibratory systolic murmur best heard between LLSB and APEX

Pulmonary (“flow”) murmur

Medium frequency systolic ejection murmur common in adolescents and adults

Venous hum

Continuous murmur, very common in 3-4 year olds

Physiologic peripheral pulmonic stenosis

Blowing systolic murmur, common in neonates
Pathologic Heart sounds

Ventricular Septal Defect

- Most common pathologic murmur.
  - Harsh, regurgitant murmur
  - Usually not heard on first day of life
  - Loud P2 means increased PA pressure
  - Diastolic rumble with CHF

- Differential Diagnosis: If at APEX, consider MR. If at LLSB, possibly TR.
- Small defects will likely close; large defects will need surgery by ~5-6 mo

Atrial Septal Defect

- Wide, fixed split S2 with systolic ejection murmur at LUSB

- Incidence: ~1:2000
- Large defects (>10 mm) unlikely to close spontaneously
- Recommend closure at ~4-5 years old
  - Surgical
  - Device closure via catheter
Hypertrophic Cardiomyopathy

- Prevalence ~1 in 500
- Familial recurrence (autosomal dominant)
- Heterogeneous natural history
  - some patients remain asymptomatic
  - some have severe heart failure
  - some have sudden death in absence of symptoms
- Phenotype rarely develops before puberty
- Annual mortality ~3 - 4% overall; ~6% in children (accounts for ~50% of sudden death in young athletes in U.S.)

Clues to diagnosis of HCM:

Prior occurrence of exertional chest pain/discomfort or syncope/near-syncope?

Excessive, unexpected, and unexplained shortness of breath or fatigue associated with exercise or normal activities?

Family history of premature death (sudden or otherwise)?

Systolic ejection murmur that intensifies with standing?

Bicuspid aortic valve

- Prevalence: ~1-2% of the population

Early systolic click at APEX

- DDx: split S1 (best at LLSB)
- Can develop aortic stenosis
  - Harsh systolic ejection murmur at RUSB
- May have aortic regurgitation
  - Early diastolic decrescendo murmur at LMSB
- Subset may develop aortic aneurysm
  - Often familial
  - Risk of aortic dissection
- Needs SBE prophylaxis
Mitral valve prolapse

- Prevalence: 2.4% of population
- Primary cause of MV repair and replacement in the U.S. (but only ~10% will require surgery)
- Major diagnostic criteria (need only 1):
  - Mid-late systolic click &/or late systolic murmur at apex, OR
  - Echo with marked prolapse of leaflet(s)

Miscellaneous heart sounds and murmurs

Primary pulmonary hypertension

Narrow S2 with loud P2 component

Dilated cardiomyopathy

S3-S4 gallop

Patent Ductus Arteriosus

Continuous murmur at LUSB, multiple clicks

Coronary fistula

Continuous murmur at apex or LLSB

Mitral stenosis

Diastolic opening snap at APEX
Auscultation Quiz*:

Patient 1 (CARD vid: 870)

2 year old, asymptomatic boy with a persistent murmur noted again on a well-child visit

a) Aortic stenosis?
b) Pulmonary stenosis?
c) Innocent murmur?

Patient 2 (CARD vid: 872)

16 year old with a murmur and large heart on CXR

a) Primary pulmonary hypertension?
b) Dilated cardiomyopathy?
c) Atrial septal defect?

Patient 3 (CARD vid: 518)

3 year old girl with a murmur at the right infraclavicular area

a) Carotid bruit?
b) Patent ductus arteriosus?
c) Innocent murmur?

Patient 4 (CARD vid: 783)

5 month old boy with a murmur first noted at 3 months

a) Patent ductus arteriosus?
b) Peripheral pulmonic stenosis?
c) Aortic flow murmur?
Patient 5 (CARD vid: 356)

9 month old with a VSD and failure to thrive

a) Large VSD with increased pulmonary artery pressure?
b) Small VSD with normal pulmonary artery pressure?
c) Small VSD with large ASD?

Patient 6 (CARD vid: 600)

5 year old boy with a recent episode of chest pain and a new murmur

a) Atrial septal defect?
b) Pulmonary stenosis?
c) Innocent murmur?

Patient 7 (CARD vid: 144)

15 year old asymptomatic teenager with two murmurs

a) Mitral stenosis and regurgitation?
b) Aortic stenosis and regurgitation?
c) VSD and pulmonary stenosis?

Patient 8 (CARD vid: 572)

9 year old with a systolic click

a) Split S1, normal finding?
b) Mitral valve prolapse?
c) Bicuspid aortic valve?

Patient 9 (CARD vid: 138)

9 year old girl with an intermittent murmur

a) Innocent murmur?
b) Mitral regurgitation post rheumatic fever?
c) Mitral valve prolapse and regurgitation?

*for answers to Auscultation Quiz, go to http://murmurlab.org. Look for the quiz case by going to “Advanced Search” and entering the VID number of the case above into the “Visit ID#” field of the search page.
References:


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