Questions

- In a patient with pericardial effusion, how can I diagnose tamponade (i.e., who needs an urgent pericardiocentesis?)
- Why is there no Kussmaul sign in tamponade? Why is there loss of Y-descent?
- What are the echo clues to constriction?
- Why is septal > lateral e’ in constriction?
- In constriction, why does hepatic vein flow reversal increase with expiration but JVP goes up with inspiration (+Kussmaul)?
Cardiac tamponade
Case presentation

• 52-year-old woman with malaise, CP
  » Low-grade fever, malaise, fatigue x 2 weeks
  » CP x 1 week, pleuritic, worse when supine, better when sitting forward, positional
  » No lightheadedness, dizziness, orthopnea, PND, syncope, or palpitations

• No prior medical history, no medications
Case presentation (continued)

- Laboratory work-up:
  - ANA, rheumatoid factor: normal
  - Chem panel, CBC: normal
  - PPD: nonreactive; HIV: negative
- Echocardiogram: normal
- Prescribed NSAIDs
- Symptoms resolved within 2-3 days
2 weeks later: recurrence of malaise, fatigue, low grade fevers, pleuritic CP; +SOB/dizziness

Physical exam:
- 99.8, 98/80, 110, 22, 96% on RA
- JVP to earlobes
- Lungs CTA bilaterally
- Distant HS, tachy, regular, no m/g/r
- Abdominal exam: benign
- Ext: 1+ edema to knees
Electrocardiogram
Electrocardiogram
It’s 2am in ER: What now??

- STAT echocardiogram
- STAT chest CT
- STAT cardiac MRI
- Insert IJ central line at bedside
- None of the above
It’s 2am in ER: What now??

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- None of the above
Cardiac tamponade... a clinical Dx

- Don’t forget pulsus paradoxus at the bedside...
  » Inflate BP cuff until you can’t hear Korotkoff sounds
  » Start deflating until you hear sounds intermittently (sounds disappear with inspiration) - Note SBP #1
  » Keep deflating until you hear sounds continuously (during inspiration and expiration) - Note SBP #2
  » Pulsus paradoxus = SBP #1 - SBP #2
    - Value > 10 mmHg? sens 98%, spec 70%, +LR 3.3, -LR 0.03
    - Value > 12 mmHg? sens 98%, spec 83%, +LR 5.9, -LR 0.03
Case presentation (continued)

- Pulsus paradoxus done at bedside:
  » Value = 18 mmHg
- ER team calls for STAT echocardiogram
- While waiting, R IJ central line placed...
CVP tracing in tamponade

- **V wave:**
  - Passive filling of the RA during RV systole

- **Y descent:**
  - TV opens, passive RA emptying

- **A wave:**
  - RA contraction

- **X descent:**
  - RA relaxation

- **Tamponade:**
  - Blunted Y descent
  - Passive emptying of RA is dependent on pressure difference between RA and RV: in tamponade, the pericardial pressure takes over all other diastolic pressures (= loss of Y descent)
Cardiac tamponade: echo signs

• Early signs:
  » IVC dilated, not collapsing
  » Increased respiratory variation in mitral (> 25%) and tricuspid (> 40%) inflows

• Late signs:
  » RA/RV collapse

• Very late signs:
  » LA/LV collapse
21% variation in mitral inflow with respiration
Urgent pericardiocentesis?

• Is the IVC dilated?
• Is there increased respiratory variation in the MV, TV inflows?
• Is there RV/RA collapse?
• Is pulsus paradoxus present?
RV Septum Posterior wall MV

Onset of systole RV diastolic collapse
~57% variation in mitral inflow with respiration
RATE OF ACCUMULATION, NOT SIZE OF EFFUSION IS MOST IMPORTANT
Tamponade: take home points

- Cardiac tamponade is a clinical diagnosis: integrate echo with pulsus paradoxus and other clinical findings to determine need for pericardiocentesis.
- Pericardial pressure takes over everything in tamponade: diastolic pressure equalization; JVP, doesn’t change with respiration (-Kussmaul sign); no Y descent.
- Rate of accumulation is more important than size of effusion.
Constrictive pericarditis
Case presentation (continued)

- The patient underwent successful pericardiocentesis (750 cc straw-colored fluid)
- Pericardial drain left in for 2 days and then successfully removed
- Transudate by Light’s criteria
- Cytology negative
- 6 months later... admitted with progressive right-sided heart failure
Case presentation (continued)

• 110/62, 92, 24, 94% on RA
• JVP 14 cm, increases with inspiration
• Lungs CTA bilaterally, decr BS at bases
• Irreg irreg, nl S1 S2, no murmurs, +diastolic extra sound
• Abd: +ascites
• Ext 2+ edema to thighs
Kussmaul’s sign: JVP rises with inspiration
Case presentation (continued)
Case presentation: tissue Doppler imaging

\[ e' = 16 \text{ cm/s} \]
Hepatic Vein
Cardiac MRI
Constriction vs. restriction

Echo is better than BNP

Average the e’ velocities

Sengupta PP et al, Am J Cardiol 2008
## Constriction vs. restriction

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Constriction</th>
<th>Restriction</th>
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</thead>
<tbody>
<tr>
<td>↑↑ E velocity, ↑ E/A</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Short E decel time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitral inflow respiratory variation</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Tissue Doppler e' velocity</td>
<td>Normal or increased</td>
<td>Severely reduced</td>
</tr>
<tr>
<td>PA systolic pressure</td>
<td>Normal</td>
<td>Increased</td>
</tr>
<tr>
<td>Hepatic vein imaging</td>
<td>Flow reversal during <em>expiration</em></td>
<td>Flow reversal during <em>inspiration</em></td>
</tr>
</tbody>
</table>
Kussmaul / hepatic vein discordance?

- In constriction:
  - JVP increases with *inspiration*
  - Hepatic vein flow reversal increases with *expiration*

- During inspiration:
  - IVC flow competes with SVC flow
  - Diaphragm squeezes abdomen → ↑IVC flow
Kussmaul / hepatic vein discordance?

- In constriction:
  - JVP increases with *inspiration*
  - Hepatic vein flow reversal increases with *expiration*

- During inspiration:
  - IVC flow competes with SVC flow
  - Diaphragm squeezes abdomen $\rightarrow$ ↑IVC flow
  - IVC flow pushes blood up into RA, impedes SVC flow coming into RA $\rightarrow$ pushes blood up into neck veins $\rightarrow$ Kussmaul’s sign
Case #1: The binge drinker who almost got a liver transplant...
Constriction: checklist

- Echo diagnosis of constriction is all about pattern recognition:
  - Diastolic septal bounce
  - Mitral inflow ↑ resp. variation, ↑E/A, decreased E deceleration time
  - Preserved e’ velocity (septal ≥ lateral)
  - Dilated IVC
  - Diastolic flow reversal during expiration
  - Reduced radial function, preserved longitudinal function
44-year-old man with chronic ascites
44-year-old man with chronic ascites
Septal e’ = 15 cm/s  
Lateral e’ = 10 cm/s
44-year-old man with chronic ascites
44-year-old man with chronic ascites

Thickened, enhancing pericardium
Case #2: Low-flow, low-gradient aortic stenosis... with a twist
63-year-old man with a history of rheumatic heart disease, severe AS, referred for TAVR
Lateral e’ = ~7 cm/s
Septal e’ = ~8 cm/s
63-year-old man with low-flow, low-gradient AS

- Cardiac catheterization:
  - Discordant RV and LV pressures

- CT: pericardial thickening (8 mm)

- Went to OR for AVR, MVR, pericardial stripping (“thick, leathery, adherent pericardium”)

- Improved symptoms but still with heart failure symptoms (NYHA class II)
Case #3: “Get with the guidelines” gone bad...
(i.e., try not to be a guideline-directed robot)
Case #2: 74-year-old man with history of CAD s/p CABG, HFrEF, progressively worsening dyspnea, and exertional dizziness
74-year-old man with HFrEF

- ACE-I and beta-blocker stopped
- Diuresed 5L, feels much better
- Attending switches on day of discharge
  » “Start guideline-directed medical therapy”
  » Low-dose ACE-I and beta-blocker started
  » Pt has syncope while walking in room, develops subdural hematoma...
Diastolic septal bounce
Diastolic septal bounce
PARASTERNAL SHORT-AXIS VIEW

Diastolic septal bounce

RV

LV
Dilated, non-collapsing IVC
1  Septal e' 0.09 m/s
No clear Kussmaul’s sign
PCWP higher than RAP, big V waves
74-year-old man with HFrEF

- Constrictive pericarditis diagnosed
- Underwent pericardial stripping
- Still with mild HFrEF but now NYHA class II and no further syncopal events
Constriction: take home points

- Echo diagnosis of constriction is all about pattern recognition:
  - Diastolic septal bounce
  - Mitral inflow resp. variation, E/A, decreased E deceleration time
  - Preserved e’ velocity (septal ≥ lateral)
  - Dilated IVC
  - Diastolic flow reversal during expiration
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thank you!

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