Pericardiocentesis in Adults

Eric Horlick
Director Structural Heart Disease Intervention Service
Peter Munk Cardiac centre
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Etiology of Pericardial Effusion

- Idiopathic syndromes
- Infectious
- Vasculitis / connective tissue diseases
- Immunopathies / hypersensitivity states
- Diseases of contiguous structures (MI, pleural disease etc)
- Disorders of Metabolism (uremia, myedema, gout, scurvy)
- Trauma (direct or indirect)
- Neoplasms
- Unspecified (Kawasaki, Fabry etc)
### Pericardial effusions

**Etiology of pericardial effusions coming to tap, Mayo Clinic experience** *(Tsang et al Mayo Clin Proc 2002)*:

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<tbody>
<tr>
<td>Malignancy</td>
<td>91(41)</td>
<td>159(39)</td>
<td>125(25)</td>
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<tr>
<td>Post-op</td>
<td>46(21)</td>
<td>92(22)</td>
<td>139(28)</td>
</tr>
<tr>
<td>Perforation: PCI, biopsy etc</td>
<td>9(4)</td>
<td>36(9)</td>
<td>71(14)</td>
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*Other*: idiopathic, infectious, CAD/MI related, renal failure, anticoagulation, chest trauma, connective tissue disease
Pericardium

- Parietal pericardium - <2 mm (collagen and elastin) - limits abrupt expansion of the heart due to hemodynamic loading
- Pericardial space - 20-50 cc of fluid
- <5 mm of separation
The pericardium consists of a visceral and parietal segment that extends from the lower third of the superior vena cava to the apex of the heart (1,2). The parietal pericardium is normally composed of collagen and elastin; it is relatively noncompliant and acts to limit abrupt expansion of the heart in response to a variety of loading conditions. Normally, a small amount of fluid is present ranging in volume from 20 to 50 cc; this may cause a slight separation between the 2 pericardial surfaces, typically not more than 5 mm.

The response of the pericardium to fluid accumulation has been well described (2–4). The compliance of the parietal pericardium increases slowly, although it can eventually accommodate large volumes; 500 cc or more may be tolerated without any hemodynamic compromise when accumulation occurs over weeks to months (Fig. 1A). However, in the setting of percutaneous intervention, fluid accumulation is abrupt and as little as 100 cc may result in hemodynamic decompensation (3,4). The noncompliant pericardium has an ejection volume curve (Fig. 1B); as intrapericardial pressure rises, the transmural pressure results in collapse of the right atrium (RA) first, followed by collapse of the right ventricle (RV) during progressively longer portions of diastole (Fig. 2).

Another pathophysiological mechanism may relate to lack of LA and left ventricular (LV) filling. There is a continuum of clinical manifestations that depends upon the speed of accumulation and the absolute volume that accumulates as well as the underlying presence or absence of associated cardiac disease (2–4); this variability ranges from early echocardiographic manifestations of right-sided chamber compression to shock and hemodynamic collapse.

When PE is a complication of an intracardiac procedure, the effusion is usually the result of a perforation and may develop rapidly. The perforation may be caused by a guidewire, dilator, sheath, balloon or guiding catheter, pacemaker lead, or excessive ablation energy. The presentation depends in part on at least 5 factors: the size of the device responsible for the perforation; the structure that is perforated, such as atrial versus ventricular myocardium, RA or LA, RV or LV; the hemodynamic state at the time of perforation; properties of the pericardium itself; and the coagulation status. Full anticoagulation in particular is a major risk factor for both PE and its sequelae. After cardiac surgery, the pericardium may be absent or adherent to the myocardial reflection and may prevent the development of tamponade, although this is not the case universally because tamponade and hemodynamic compromise can result from a posterior localized effusion (and may be particularly difficult to reach during attempted pericardiocentesis).

### Abbreviations and Acronyms
- PE: pericardial effusion
- LA: left atrial/atrium
- LV: left ventricular/ventricle
- RA: right atrial/atrium
- RV: right ventricular/ventricular
Cardiac tamponade occurs when fluid accumulates in the pericardial space, compressing the heart and impairing its function. The consequences of cardiac tamponade range from barely noticeable effects to overt hemodynamic collapse.

Cardiac output begins to fall as intrapericardial pressure equalizes with central venous, right atrial, and right ventricular pressures. This leads to a decrease in cardiac output and hemodynamic instability.

**Figure 1.** Relationship Between Intracardiac Filling Pressures and Intrapericardial Pressure and Cardiac Output

- **Left Heart Filling Pressure**
- **Right Heart Filling Pressure**
- **Intrapericardial Pressure**

**Increasing Pericardial Effusion Volume**

As pericardial fluid volume increases to the limit of pericardial compliance, intrapericardial pressure rises. Cardiac output begins to fall as intrapericardial pressure equalizes with left atrial and left ventricular end-diastolic pressures (left heart filling pressures).

**Increasing Pericardial Effusion Volume**

- The clinical examination for cardiac tamponade can rule out tamponade in patients with only subtle symptoms and signs.
- Echocardiography is a noninvasive modality that can be used most frequently to evaluate cardiac tamponade.

**Cardiac Output in Cardiac Tamponade**

- Cardiac output decreases as intrapericardial pressure increases, leading to hemodynamic collapse.
- The consequences of cardiac tamponade range from barely noticeable effects to overt hemodynamic collapse.

**Conclusion**

Diagnosis of cardiac tamponade relies on the integration of clinical examination, echocardiography, and hemodynamic measurements. Early recognition and therapeutic intervention are crucial to prevent circulatory collapse and improve patient outcomes.

**References**

1. [Source 1]
2. [Source 2]
3. [Source 3]
4. [Source 4]
5. [Source 5]
6. [Source 6]
7. [Source 7]
8. [Source 8]
9. [Source 9]
10. [Source 10]
11. [Source 11]
12. [Source 12]

**Graphical Summary**

- Normal hemodynamic states versus cardiac tamponade states.
- Graphs illustrating the effects of increasing pericardial effusion volume on intrapericardial pressure and cardiac output.

**Key Points**

- Cardiac tamponade occurs when pericardial fluid volume reaches the pericardial compliance limit.
- Intrapericardial pressure rises, leading to decreased cardiac output and hemodynamic instability.
- Early diagnosis and therapeutic intervention are critical to prevent complications.

**Further Reading**

- [Additional resources for understanding cardiac tamponade and diagnostic strategies.]

**Image Notes**

- Figure 1: Diagram illustrating the relationship between intracardiac filling pressures and intrapericardial pressure, with corresponding changes in cardiac output.
- Graphs showing the effects of increasing pericardial effusion volume on intrapericardial pressure and cardiac output.

**Patient Considerations**

- **Clinical Symptoms:** Chest pain, dyspnea, orthopnea, and hypotension.
- **Physical Examination:** Compression of cardiac structures, elevated jugular venous pressure, and alterations in cardiac sounds.
- **Diagnostic Tests:** Echocardiography, thoracentesis.
- **Therapeutic Approach:** Ultrasound-guided pericardiocentesis, and if necessary, surgical intervention.

**Conclusion**

The diagnosis of cardiac tamponade should not be delayed, as early intervention is crucial to prevent hemodynamic collapse and improve patient outcomes.

**Acknowledgments**

- [Acknowledgments to contributors and institutions involved in the research and publication of the study.]

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Sensitivity of Symptoms and Signs of Use in Tamponade (non procedural)

- **Dyspnea** in 88-89% of patients
  - Chest pain, Cough, Fever, lethargy, palpitations in < 25%
- **Pulsus > 10 mmhg** - 82%
- **Tachcardia** in 77%
- **Increased JVP** in 76%
  - Hypotension 26%
- **Cardiomegaly on CXR** 89%
Absent Pulsus Paradoxicus

- Hypotension
- Pericardial Adhesions
- Aortic regurgitation
- ASD
- RVH
Echocardiographic changes in the progression of tamponade

- Collapse right atrium
- Collapse right ventricle - progressively longer periods of diastole
- Left sided compression occurs during severe tamponade or when a loculated portion of an effusion affects the left heart only (classic - rupture AV groove circumflex)
2 Types Tamponade

- Tamponade
- Tamponade from something you have done

**Early Career Advice:** If you do something that becomes complicated.... Never leave your patient. If they go to the OR or the ICU

**HOVER**

Communication and Coordination
Whoever is next will wait
Never start next case if last patient is unresolved
5 factors determine outcome of procedural perforation

- size of the perforating device
- structure that is perforated
- hemodynamic state at the time of perforation
- coagulation status
- properties of the pericardium itself
85 yo female
recent NSTEMI
Turned down for surgery for frailty
Echo PG 135 mg 95 AVA 0.4 LV normal
Recurrent admission for CP CHF
3.0 X 16 stent
After I covered stent 3.0 X 12
Heart Bobbing in Contrast
Immobilized left heart border
ZMED -2 20 mm balloon
PG 58 to 21 post BAV
Al 2+
Show me how to make an Omlette
Pre-pericardiocentesis management in the setting of Tamponade

- oxygen
- position the patient, approx 45 degrees
- avoid sedation, narcotics
- generous skin infiltration with lidocaine
- fluids useful if hypovolemic
Pericardiocentesis procedures

• Directed echo examination:
  – if feasible prior to prepping/draping the patient
  – patient in position for pericardiocentesis
  – directed study to identify surface point and angulation where fluid accumulation is maximal and distance to fluid is the closest
  – depth should be reduced to focus on the effusion and nearby cardiac structures only
Apical view of a large pericardial effusion
Directed study.....

Depth is reduced to focus on the distance to the effusion and the local relationship to cardiac structures.

Measurement of skin to effusion distance, and depth of effusion.
Pericardiocentesis: General Procedures

• If feasible (non-arrest) collect supplies first

DON’T FORGET TO SEND FLUID FOR EVERYTHING chemistry, cell count, cytology, bacterial/fungal cultures etc
Subcostal approach to pericardiocentesis

Needle inserts between xiphoid process and left costal margin

Initial angle 15 degrees to get under the costal margin

Hub is then depressed to aim for the left shoulder
Agitated saline confirming appropriate positioning
Agitated saline confirming you have a problem

If this occurs, reposition the drain in the pericardium
Chest wall (apical) approach to pericardiocentesis

- usually apical, but can be left axillary, parasternal,…
- left internal thoracic artery is in jeopardy if injecting within 5 cm of the parasternal border (may be seen on colour doppler echo as arterial structure parallel with the sternum, depth around 2 cm)
Pericardiocentesis

• Abandoned approaches
  – transduced ECG for guidance
  – transduced pressure to detect pericardial pressure (and hopefully not LV/RV pressure)
  – fluoroscopy guidance (for the most part)
Complications

• Major complication rate of 1.3 to 1.6% including:
  – cardiac perforation
  – coronary perforation
  – pneumothorax
  – serious arrhythmias
  – infections
Severe Cardiogenic shock in a 68 yo female with a history colorectal malignancy resection 2 yrs prior presented in tamponade with BP 60/40. After 800 cc pericardiocentesis severe cardiogenic shock - CI 0.9, RA 21 mmhg, RVEDP 19 mmhg, RVEF 15%, normal cors, recovered after 5 days of inotropes
Balloon Pericardiotomy

- Reported by Palacios in 1991
- Initially done for refractory pericardial reaccumulation
- Pericardiocetesis for malignancy has a 13-50% recurrence rate
- Surgery has associated risk and a 4.9% recurrence

Fig. 1. Drawing depicts how pericardium-peritoneum opening is created by balloon pericardiotomy.
• 50 pts
• was after initial drainage failure (>100cc X 3d) or primarily
• after samples sent 20 cc of 50:50 contrast mixture injected into the residual 100-200cc of fluid
• track dilated with 10 fr dilator
• balloon positioned to straddle the pericardial margin - slowly inflated
• If skin was apposed to chest wall traction put on skin to isolate pericardium
• 22 of 50 had 2 sites dilated to obtain free flow of pericardial fluid.

• 4 pts failed and required surgery for reaccumulation (2 pts had recurrence after surgery)

• 1 pt who needed surgery had bleeding from a small pericardial vessel

<table>
<thead>
<tr>
<th>Table 3. Follow-Up Findings in 50 Patients After Percutaneous Balloon Pericardiotoromy</th>
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<tbody>
<tr>
<td>Successful procedure</td>
</tr>
<tr>
<td>Unsuccessful procedure</td>
</tr>
<tr>
<td>Recurrence of effusion or tamponade</td>
</tr>
<tr>
<td>Bleeding requiring surgery</td>
</tr>
<tr>
<td>Persistent catheter drainage requiring surgery</td>
</tr>
<tr>
<td>Complications</td>
</tr>
<tr>
<td>Fever</td>
</tr>
<tr>
<td>Pleural drainage performed within 30 days</td>
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<tr>
<td>With preexisting pleural effusion</td>
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<tr>
<td>Without preexisting effusion</td>
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<tr>
<td>Pneumothorax</td>
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<tr>
<td>Mean follow-up duration (months)</td>
</tr>
<tr>
<td>Deaths</td>
</tr>
<tr>
<td>History of malignancy</td>
</tr>
<tr>
<td>No history of malignancy</td>
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<tr>
<td>Mean survival (months)</td>
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Data are presented as number of patients or mean value ± SD.

* after fever noted - all pts received prophylactic abx - no further patients had fever
Summary

1. Pericardiocentesis is a relatively straightforward procedure

2. A quick focused echo makes for the safest procedure (in an emergency go subcostal)

3. Have all your equipment ready and prepared beforehand and make sure to send the fluid for all relevant examinations

4. Make a movie in your head of how and in what order you will direct your team for an emergency tap

5. If a procedural tap is imminent - judge the relative merits of efforts to stop bleeding while mobilizing personnel and timing of a tap