Constrictive Pericarditis
Echo Doppler is the GOLD standard

Jae K. Oh, MD
Mayo Clinic

From Tamponade to Constriction
Non-invasive Hemodynamics

Jae K. Oh, MD
Pericardial Diseases
Contents

• Tamponade vs Effusive Constrictive Pericarditis
• Echo Diagnostic Criteria (4 parameters)
  • Respiratory variation in ventricular septal motion
  • Mitral inflow velocity
  • Mitral annulus e’ velocity
  • Hepatic vein diastolic flow reversal with expiration
• Myocardial diseases vs constrictive pericarditis
• Diastolic function is the key for diagnosis and prognosis

Spectrum of Pericardial Diseases

Pericarditis
Chest pain, HF

P. Effusion
Tamponade

Constriction

Effusive
Constrictive

Cure

Cardiac Surgery
Radiation

NSAID
Steroid
Surgery

Tap
Cardiac Tamponade
Echocardiographic Diagnosis

RV Collapse  RA Collapse  Swinging Heart

Cardiac Tamponade: Characteristic Doppler Observations

Pure tamponade: Grade 1 pattern with minimal diastolic forward flow with expiration

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Mitrail Inflow
E < A velocity

Hepatic Vein
Diastolic reversal with expiration

Pure Cardiac Tamponade

Grade 1 Diastolic Function

Medial e’ 6 cm/s

LVOT Doppler: Pulsus Paradoxus

27 year old man underwent a window
Referred to Mayo

- Acute Pericarditis with effusion
- Pericardial Window
- Pericardial fluid …studies were negative
- Not feeling better
Effusive-Constrictive Pericarditis

27 yo man after pericardial window

Hepatic Vein Expiratory Diastolic Flow Reversal

Mitral Inflow

Mitral e’ = 15 cm/sec
Diagnosis of Constriction

- JVP elevation with rapid “y” descent
- Pericardial Knock
- Hepatomegaly
- Pitting edema
- Calcified pericardium
Constrictive Pericarditis
Traditional Diagnostic Criteria

- JVP Elevation: Kussmaul: Can be seen in RCM
- Pulsus Paradoxus: Can be seen in COPD, Obesity
- Thick Pericardium: Normal in 20% of CP
- Calcified Pericardium: In 20% of CP
- Equalization of End-diastolic Pressures: Also in RCM
- Pulmonary Artery Systolic Pressure < 50 mmHg: 1/3 have PASP higher than 50 mmHg

Diagnosis of constriction should be based on Characteristic HEMODYNAMICS

Hemodynamics in Constriction
Intracardiac pressure $\Delta <$ intrathoracic pressure $\Delta$
Interventricular dependence
Medial e’ velocity a key in CP vs RCM

Echocardiographic Diagnosis of Constrictive Pericarditis: Mayo Clinic Criteria
Terrence D. Welch, Lieng H. Ling, Raul E. Espinosa, Nandan S. Anavekar, Heather J. Wiste, Brian D. Lahr, Hartzell V. Schaff and Jae K. Oh

Welch et al Circ Imaging 2014
Myocardial or Pericardial?

71 yo man with worsening dyspnea 2 years after CABG

- Physical Examination
  - JVP elevation
  - Prominent S3
  - Peripheral edema
- Cardiac Cath…Equalized end-diastolic pressures
- CT was obtained: Calcified Pericardium
71 year old man with calcified pericardium
Referred for Pericardiectomy

70 year old man with HF referred to Cardiomyopathy Clinic

- 2 months history of increasing dyspnea and fluid retention
- Pleural effusion: Treated with thoracentesis
- Abnormal light chain with increased kappa
- Family history of Myeloma and Amyloidosis
- Cardiac catheterization: Normal coronaries
  - LVEDP = 28, PA = 41/21, PAWP = 23, RV = 38/13, CI = 1.9
70 year old man with heart failure with preserved LVEF

What is your next step?
1= Pyrophosphate scan
2= Cardiac cath
3= Cardiac MRI
4= Surgery

Constriction vs Restrictive Myocardial Disease
Traditional Hemodynamic Data Comparison

- Equalization LV/RV End-diastolic pressure
- Pulmonary artery systolic pressure (PASP) ≤ 50 mmHg
- RV EDP / PASP ≥ 1/3

Vaitkus and Kussmaul AHJ 1991
Talreja, Nishimura et al. JACC 2008
26 yo male with HF after viral illness

Right and left heart catheterization
No Constriction!

FINAL DIAGNOSIS
1. Mildly elevated multichamber diastolic pressures
2. Normal dominant left coronary artery
3. 2500cc saline bolus administered

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<thead>
<tr>
<th></th>
<th>RA</th>
<th>RV</th>
<th>PA</th>
<th>LV</th>
<th>PCWP</th>
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<tbody>
<tr>
<td>Rest</td>
<td>11</td>
<td>30/7, 16</td>
<td>25/14/19</td>
<td></td>
<td>12</td>
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<tr>
<td>After 2.5 L saline</td>
<td>29/10, 16</td>
<td>124/8, 18</td>
<td>13</td>
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Exercise Echocardiography in Constriction

Medial e' stress 24 cm/sec

Hepatic Vein Doppler

Constriction
Myocardial Disease
Severe TR
Heart failure with ascites and leg edema

Hepatic Vein Doppler

Annulus Reversus
Severe TR and CP

Medial e’ = 12 cm/sec
Lateral e’= 9 c/sec
Constriction with Atrial Fibrillation

Medial $e' = 11\, \text{cm/s}$

Lateral $e' = 7\, \text{cm/s}$

Constriction with A. Fibrillation After Cardioversion
33 yo male with morbid obesity BMI 76
Referred from Lymphedema Clinic

Lateral e' = 12 cm/s
Medial e' = 18 cm/s

33 yo male with morbid obesity BMI 76 (550 lbs)
Referred from Lymphedema Clinic
# Pure vs Mixed Constriction

## Mitral and Tricuspid Annular Velocities Before and After Pericardiectomy in Patients With Constrictive Pericarditis

Gabriella Veress, MD; Lieng H. Ling, MD; Kye-Hun Kim, MD, PhD; Jacob P. Dal-Bianco, MD; Hartzell V. Schaff, MD; Raul E. Espinosa, MD; Rowlens M. Melduni, MD; Jamil A. Tajik, MD; Thoralf M. Sundt, Ill, MD; Jae K. Oh, MD

<table>
<thead>
<tr>
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<th>Primary CP Baseline</th>
<th>Secondary CP</th>
<th>Primary CP Post Pericardiectomy</th>
<th>Secondary CP</th>
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<tbody>
<tr>
<td>Medial e’</td>
<td>14.6 ± 3.4</td>
<td>10.3 ± 3.5</td>
<td>9.0 ± 2.9</td>
<td>7.0 ± 2.0</td>
</tr>
<tr>
<td>Lateral e’</td>
<td>12.8 ± 3.8</td>
<td>10.3 ± 2.8</td>
<td>10.0 ± 3.0</td>
<td>7.6 ± 2.0</td>
</tr>
</tbody>
</table>

Veress et al. Circulation CV Imaging July 2011

![Waveform](image)
Pericardium was of normal thickness (≤2 mm) in 18% and this group was mostly from cardiac surgery, radiation and previous MI with same hemodynamics.

RAP/PAWP is lower in patients with relatively normal pericardial thickness.
Survival after Pericardiectomy Predictors: Medial e', PAP, and E/e'

**A**  
**e’ Velocity**

- < 9.0 cm/s: 35, 16, 5
- ≥ 9.0 cm/s: 69, 64, 24

**B**  
**Mean PAP**

- ≥ 29 mmHg: 44, 20, 0
- < 29 mmHg: 60, 49, 21

**C**  
**Medial E/e’**

- < 8: 50, 41, 21
- 8-15: 31, 19, 5
- > 15: 23, 9, 3
The establishment of the diagnosis of chronic constrictive pericarditis has a three-fold importance:
1. It affords the explanation of a group of symptoms and signs in an obscure case;
2. It obviates confusion with other conditions;
3. Expert thoracic surgery may now lead to cure what was once a hopeless disease.

Pericardiectomy for Constrictive Pericarditis
Mayo Clinic (n=1,066)

Year of surgery

Total patients

Murashita, Schaff, Greason et al Ann Thorac Surg 2017
Tamponade to Constriction: Summary
Non-invasive Hemodynamics

- A spectrum of disease
- Tamponade and Constriction diagnosed by Echo hemodynamics
- Mitral inflow pattern can predict effusive constrictive pericarditis
- Effusive CP
  - 10-20% after Tap
  - Medical Rx possible
- Non-invasive hemodynamic assessment can be more reliable than invasive hemodynamics

Pericardial Diseases Team
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- Michel Senni, MD
- Gabriella Veress, MD
- Lieng Ling, MD
- Smonporn Boonyaratavej, MD
- Terrence Welch, MD
- F. Syed, MD
- Dali Feng, MD
- D. Talreja, MD
- WM Soo, MD
- J. Dal-Bianco, MD
Cardiac Magnetic Resonance Imaging Pericardial Late Gadolinium Enhancement and Elevated Inflammatory Markers Can Predict the Reversibility of Constrictive Pericarditis After Antiinflammatory Medical Therapy
A Pilot Study

DaLi Feng, MD; James Glockner, MD, PhD; Kyehun Kim, MD; Matthew Martinez, MD; Imran S. Syed, MD; Philip Araoz, MD; Jerome Breen, MD; Raul E. Espinosa, MD; Thoralf Sundt, MD; Hartzell V. Schaff, MD; Jae K. Oh, MD

MRI DE in 2 patients with Constriction

Baseline

Medical RX

3 Months

Circulation Oct 3rd 2011

Transient Constrictive Pericarditis
One week of Steroid Rx
Restriction or Constriction?
Diagnosis based on 2-D, e’ and strain imaging

Medial e’ = 5 cm/s

Medial e’ = 11 cm/s
An e-mail from a junior staff at a major MC 52 year old man with RCM waiting for heart transplantation (Had Echo, MRI, and cardiac cath performed)

Explanted Heart
A 27 yo woman with Asthma
Marked Septal Motion Abnormality

A 27 yo woman with dyspnea
Constrictive Pericarditis?

Mitral Inflow

E’ = 10 cm/sec
A 27 yo woman with dyspnea
Pulsus Paradoxus with Asthma

Constrictive vs COPD/Asthma
SVC Flow Velocities

Echo Asia 2020 in HongKong (May 22-24)