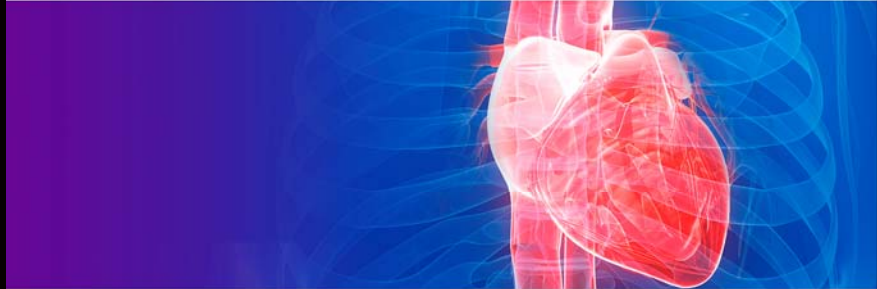
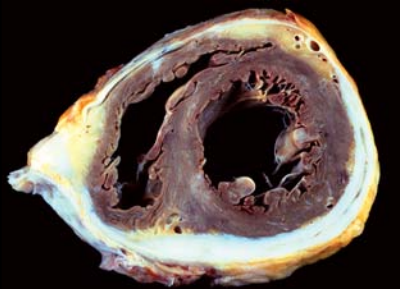




Constrictive Pericarditis

Curable Paradoxical Diastolic Heart Failure

ASE EBRC 2018



May 8th, 2018

Jae K. Oh, MD
 Samsung Professor of CV Diseases
 Director, Pericardial Disease Clinic
 Co-Director, Integrated CV Imaging

Constrictive Pericarditis

Contents

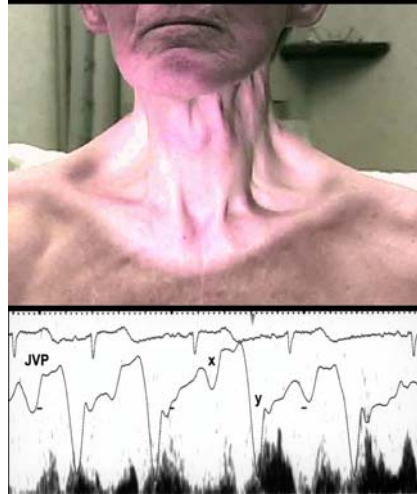
- Clinical features and Diagnostic criteria
 - Symptoms and signs
 - Imaging
 - Hemodynamics
 - Echo Diagnosis
 - Constriction Mimickers
- Effusive-constrictive Pericarditis
- Management
- Summary



Constrictive Pericarditis

Symptoms/Signs & Exam Findings

- Right Heart Failure
- Ascites
- Edema
- Abdominal pain
- JVP elevation with Kussmaul
- Rapid “y” descent of JVP
- Pericardial Knock (S3)
- Pleural effusion



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Constrictive Pericarditis

Traditional Imaging and Hemodynamic Features

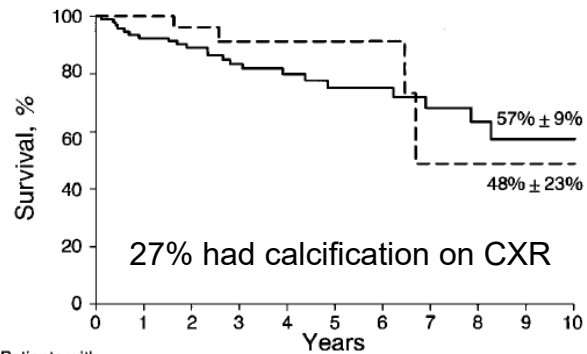
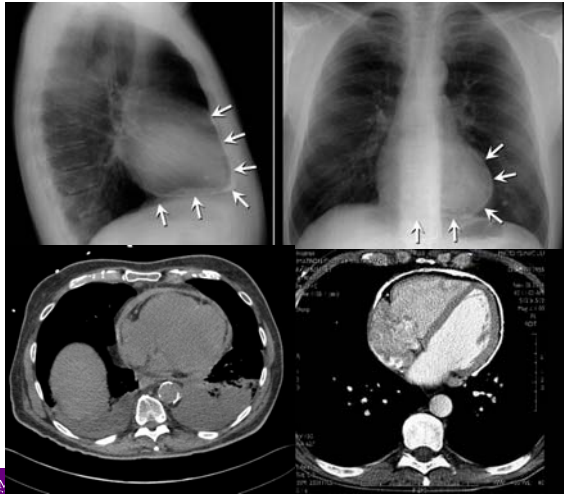
- Pericardial calcification (CXR and CT)
- Increased pericardial thickness (Echo, CT, and MRI)
- Hemodynamics by Cath
 - Increased RA pressure with rapid “y” descent
 - Equalization of LV/RV end-diastolic pressures
 - Dip and Plateau (M or W pattern)
 - Pulmonary artery systolic pressure < 50 mmHg
 - High ratio between RV end-diastolic and systolic pressure



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Calcific Constrictive Pericarditis: Is It Still with Us?

Lieng H. Ling, MBBS, MRCP; Jae K. Oh, MD; Jerome F. Breen, MD; Hartzell V. Schaff, MD; Gordon K. Danielson, MD; Douglas W. Mahoney, MSc; James B. Seward, MD; and A. Jamil Tajik, MD



Patients with Calcification, n	28	21	17	14	8	5	2	2	2	1
Patients with no Calcification, n	82	71	53	40	30	25	17	13	10	7

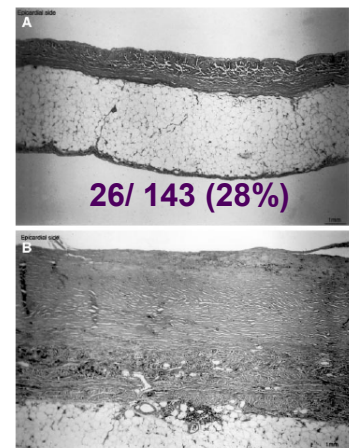
Ling et al AIM 2000

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Constrictive Pericarditis in 26 Patients With Histologically Normal Pericardial Thickness

Deepak R. Talreja, MD; William D. Edwards, MD; Gordon K. Danielson, MD; Hartzell V. Schaff, MD; A. Jamil Tajik, MD; Henry D. Tazelaar, MD;

	Group 1 (n=26)	Group 2 (n=117)	P
Hemodynamic Criterion			
Right atrial pressure, mm Hg			
Preoperative	21	22	≤0.39
Postoperative	12	11	≤0.38
Pulmonary artery systolic pressure, mm Hg			
Preoperative	39	38	≤0.87
Postoperative	34	32	≤0.36
Pulmonary artery diastolic pressure, mm Hg			
Preoperative	20	22	≤0.17
Postoperative	16	15	≤0.61
Cardiac output, L/min			
Preoperative	3.9	4.2	≤0.19
Postoperative	5.8	7.2	≤0.08
Cardiac index, L·min⁻¹·m⁻²			
Preoperative	1.9	2.4	≤0.17
Postoperative	3.0	3.6	≤0.49



Talreja , Oh et al. Circulation 2003

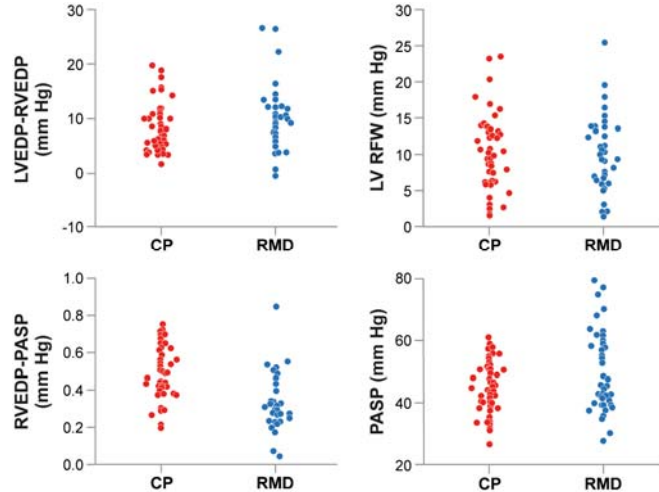
MAYO CLINIC

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Constriction vs Restrictive Myocardial Disease

Traditional Hemodynamic Data Comparison

- Equalization LV/RV End-diastolic pressure
- Pulmonary artery systolic pressure (PASP) ≤ 50 mmHg
- $RVEDP / PASP \geq 1/3$



Vaitkus and Kussmaul AHJ 1991

Talreja, Nishimura et al. JACC 2008

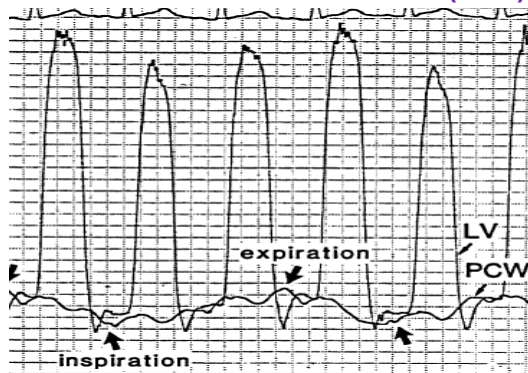
©2018 MFMR | 3712003-7

Differentiation of Constrictive Pericarditis and Restrictive Cardiomyopathy by Doppler Echocardiography

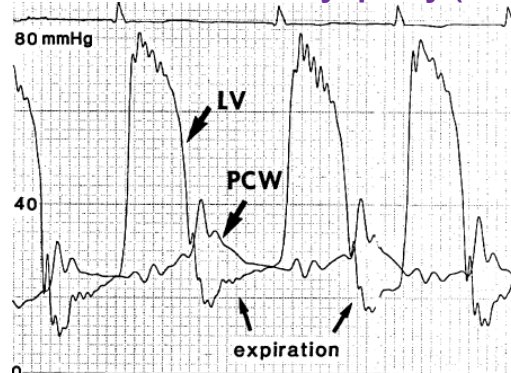


Liv K. Hatle, MD, Christopher P. Appleton, MD, and Richard L. Popp, MD

Constrictive Pericarditis (N=7)



Restrictive Cardiomyopathy (N=11)



“Dissociation between Intracardiac and Intrathoracic Pressure”

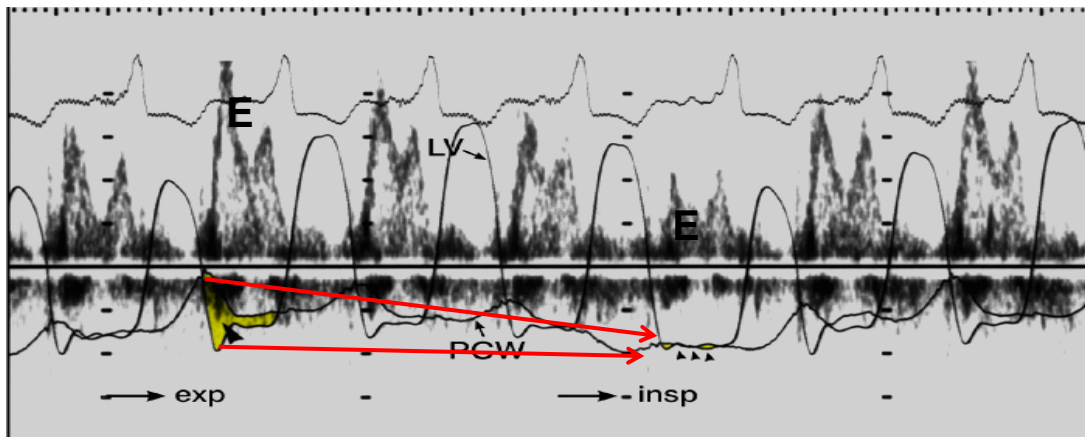


Hatle et al. Circulation 1989

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Constrictive Pericarditis

Mitral Inflow vs Cath



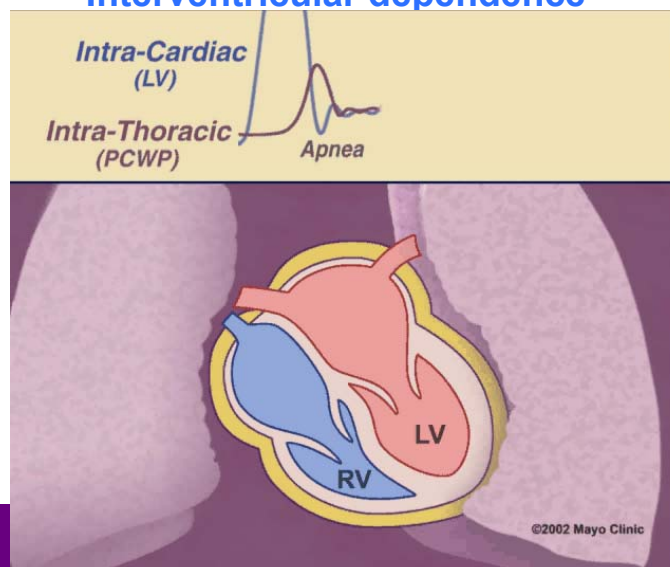
Dissociation between intrathoracic and intracardiac pressures
Differential ventricular filling with respiration



CP052397-09
 ©2018 MFMR | 3712003-9

Hemodynamics in Constriction

Intracardiac pressure Δ < intrathoracic pressure Δ
Interventricular dependence

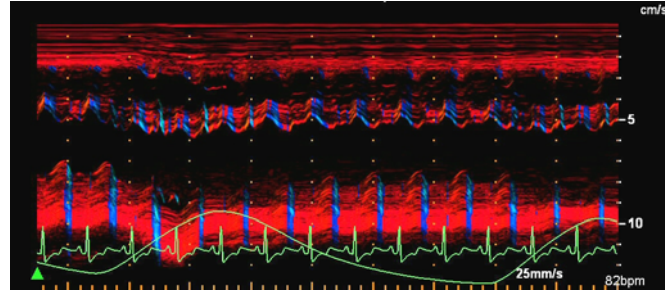
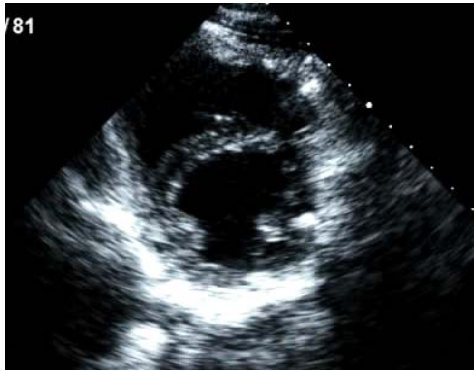


©2002 Mayo Clinic

CP1051850-19
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Constriction Ventricular Septal Motion Abnormality

“Consider constriction if there is septal motion abnormality in patients with HF and preserved EF (HFpEF)”

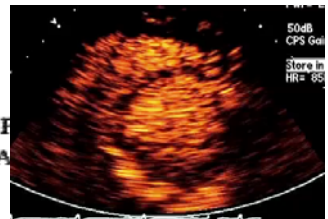


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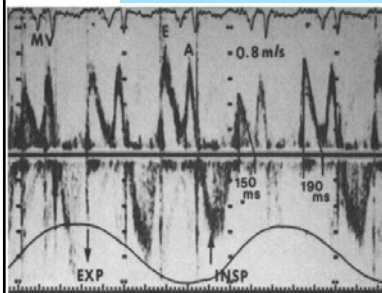
Diagnostic Role of Doppler Echocardiography in Constrictive Pericarditis

JAE K. OH, MD, FACC, LIV K. HATLE, MD, JAMES B. SEWARD, MD, FACC, GORDON K. DANIELSON, MD, FACC, HARTZELL V. SCHAFF, MD, FACC, GUY S. REEDER, MD, FACC, A. JAMIL TAJIK, MD, FACC

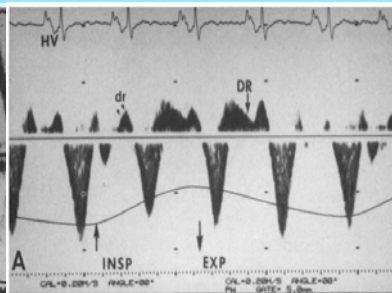
Rochester, Minnesota



Doppler was diagnostic for CP in 22 of 25 (88%) patients who were proven to have constriction at the time of operation



Mitral Inflow Doppler



Hepatic Vein Doppler

Echo Dx of Constriction

1. Abnormal Septal Motion
2. Restrictive Mitral Inflow with Respiratory Variation > 25%
3. Hepatic Vein Diastolic Flow Reversals with Expiration

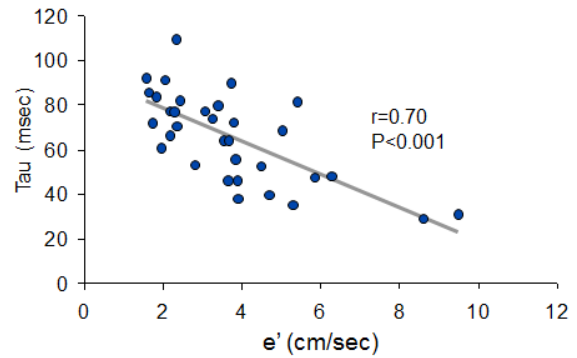
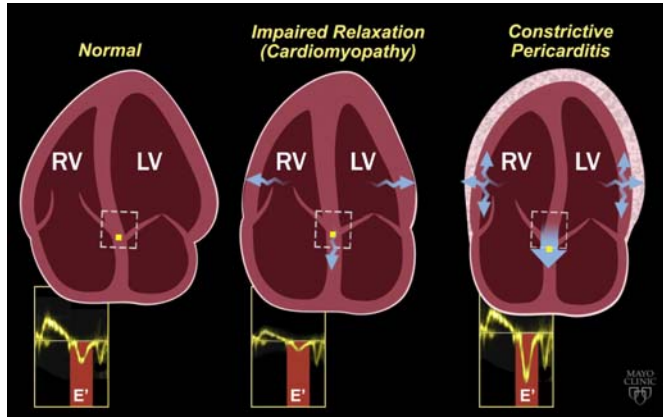


Oh et al JACC 1994

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Diastolic Function Assessment by Echo

e' velocity reflects LV relaxation

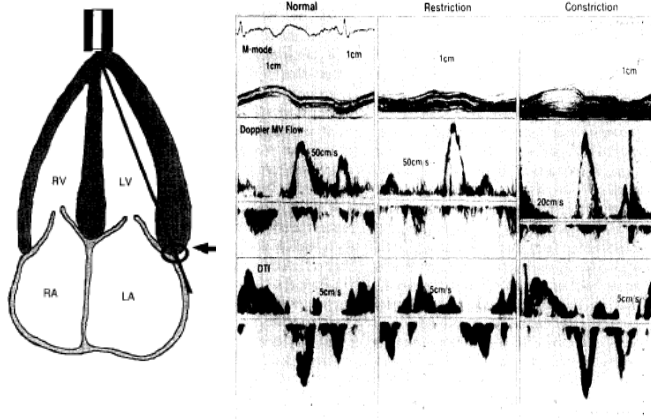


Firstenberg et al: J Appl Physiol, 2001, Nagueh et al: JACC 1997, Oki et al: AJC 1997, Sohn et al: JACC 1997, Ommen et al: Circ 2000 Opdahl et al: Circulation 119:2578, 2009, and more.

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Differentiation of Constrictive Pericarditis From Restrictive Cardiomyopathy: Assessment of Left Ventricular Diastolic Velocities in Longitudinal Axis by Doppler Tissue Imaging

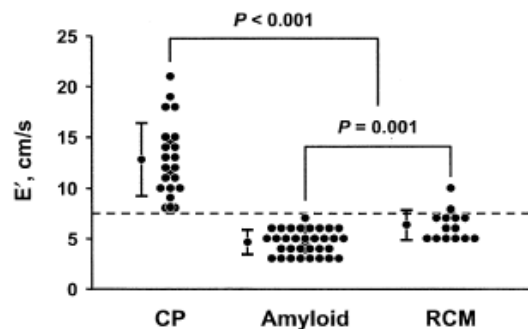
MARIO J. GARCIA, MD, LEONARDO RODRIGUEZ, MD,* MIGUEL ARES, MD,* BRIAN P. GRIFFIN, MD,* JAMES D. THOMAS, MD, FACC,* ALLAN L. KLEIN, MD, FACC



M. Garcia JACC 1996

Differentiation of Constrictive Pericarditis from Restrictive Cardiomyopathy Using Mitral Annular Velocity by Tissue Doppler Echocardiography

Jong-Won Ha, MD, PhD, Steve R. Ommen, MD, A. Jamil Tajik, MD, Marion E. Barnes, MSc, Naser M. Ammash, MD, Morie A. Gertz, MD, James B. Seward, MD, and Jae K. Oh, MD

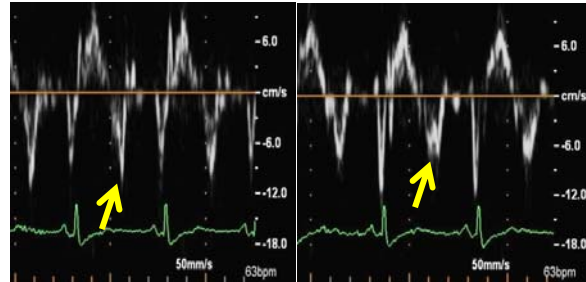


JW Ha et al AJC 2004

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Using mitral 'annulus reversus' to diagnose constrictive pericarditis

Christina S. Reuss¹, Susan M. Wilansky¹, Steven J. Lester¹, Joan L. Lusk¹, Diane E. Grill², Jae K. Oh³, and A. Jamil Tajik^{1*}



Medial $e' = 12$ cm/s

Lateral $e' = 8$ cm/s



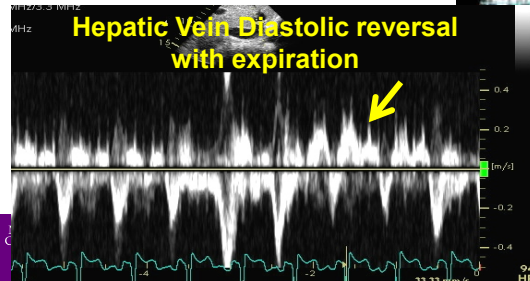
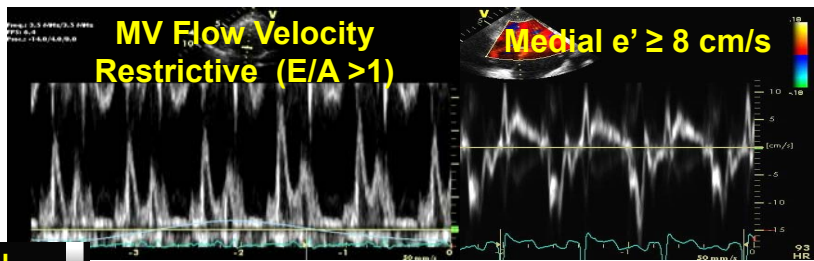
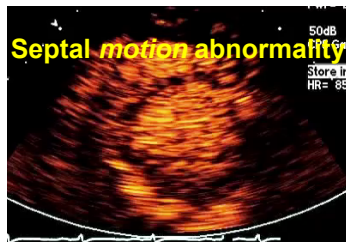
Reuss et al, EHJ Imaging June 2008

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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

Echo Diagnostic Criteria



Sensitivity	87 %
Specificity	91 %

Welch et al Circ Imaging 2014

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Illustrative Cases Diagnosis and Management

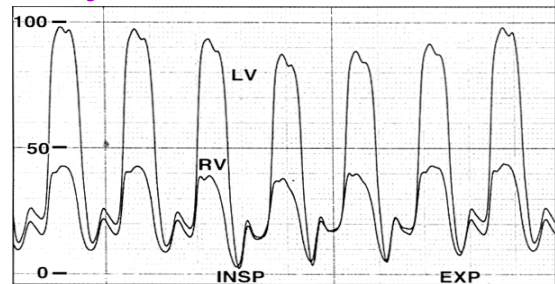


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71 year old man with dyspnea 2 years after CABG

- Physical Examination

- JVP elevation
- Prominent S3
- Peripheral edema

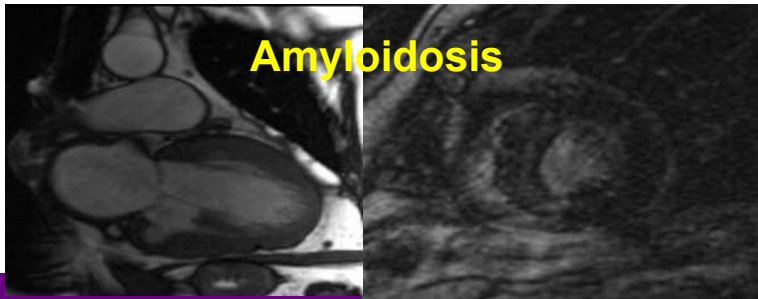
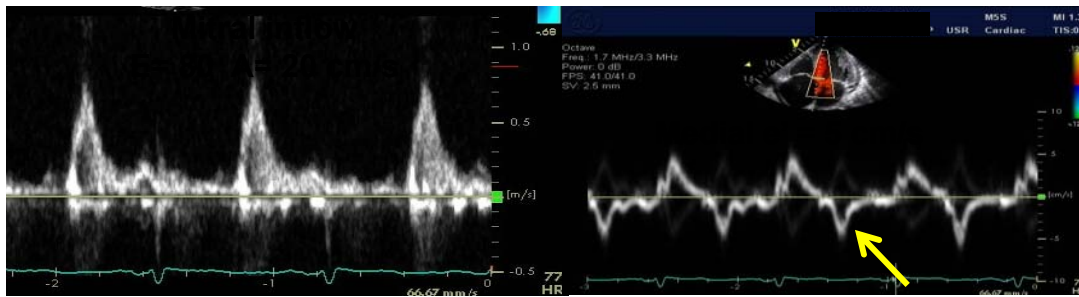


- Cath : Equalized end-diastolic pressures
- CT was obtained: Calcified Pericardium



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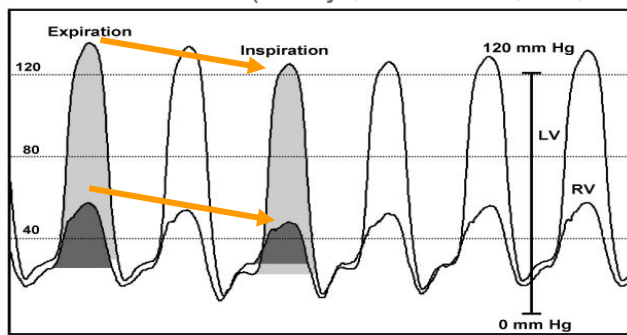
71 year old man with calcified pericardium



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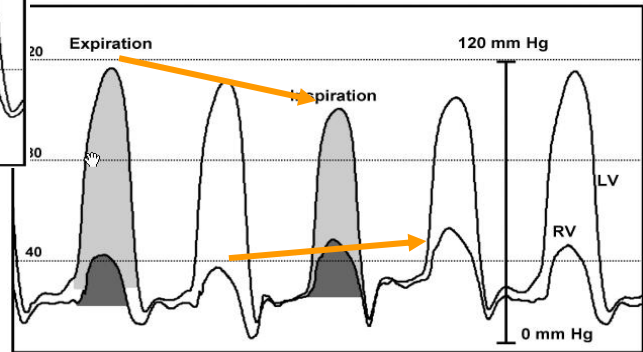
Constrictive Pericarditis in the Modern Era

Novel Criteria for Diagnosis in the Cardiac Cath Laboratory
(Talreja, Nishimura, Oh, Holmes. Jan. 2008 JACC)



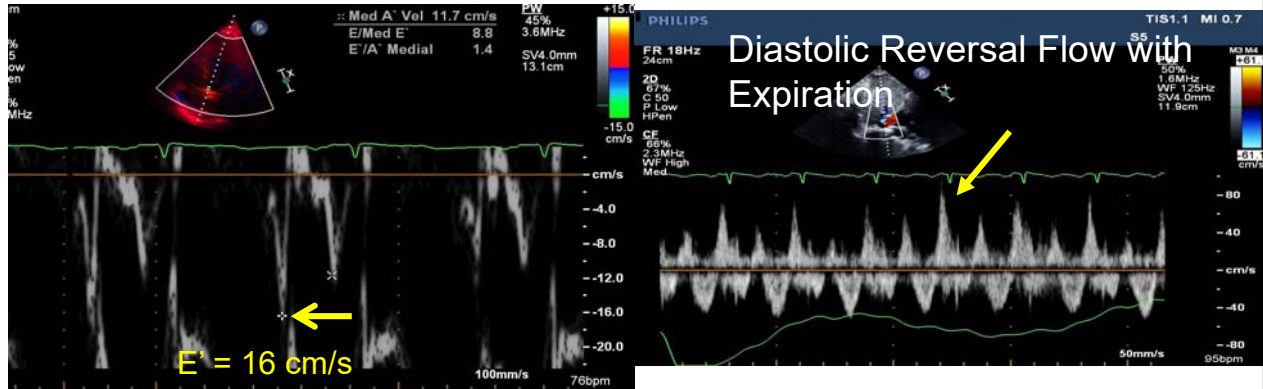
Concordant change
Restrictive CM

Discordant change
Constriction



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52 year old man with NYHA 3-4 waiting for heart transplantation
 (had Echo, Cath, and MRI)
 You just took over his care in HF service. What would you do?

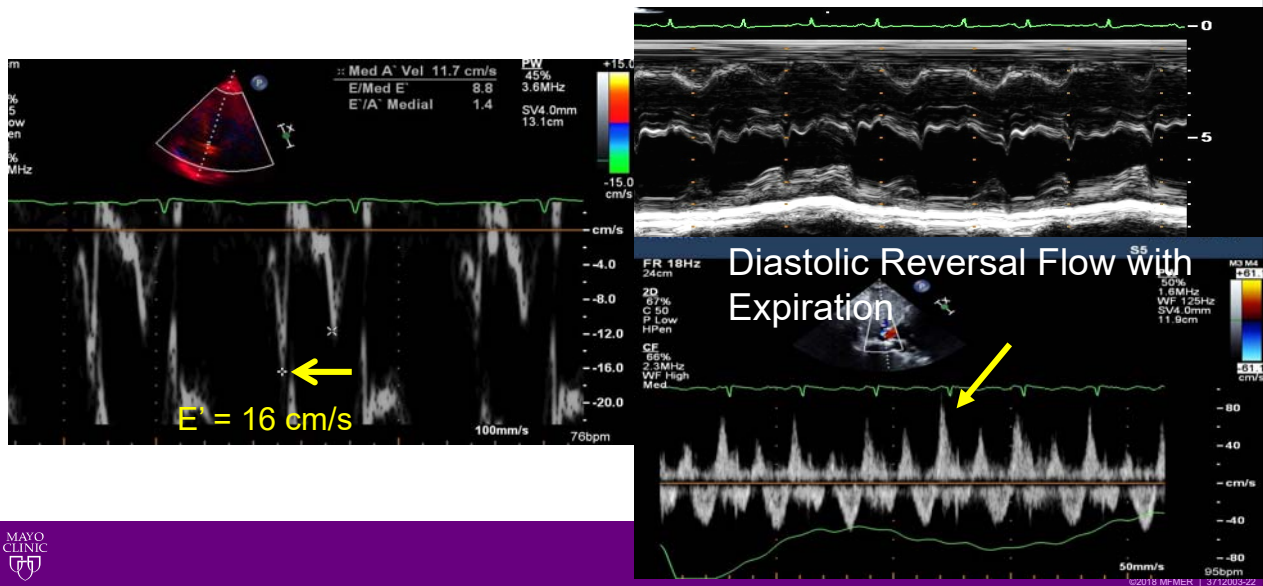


- 1= Pericardiectomy 2= Transplantation 3= Myocardial Bx 4=Repeat Cath
- 5= A long talk with previous staff and surgeon



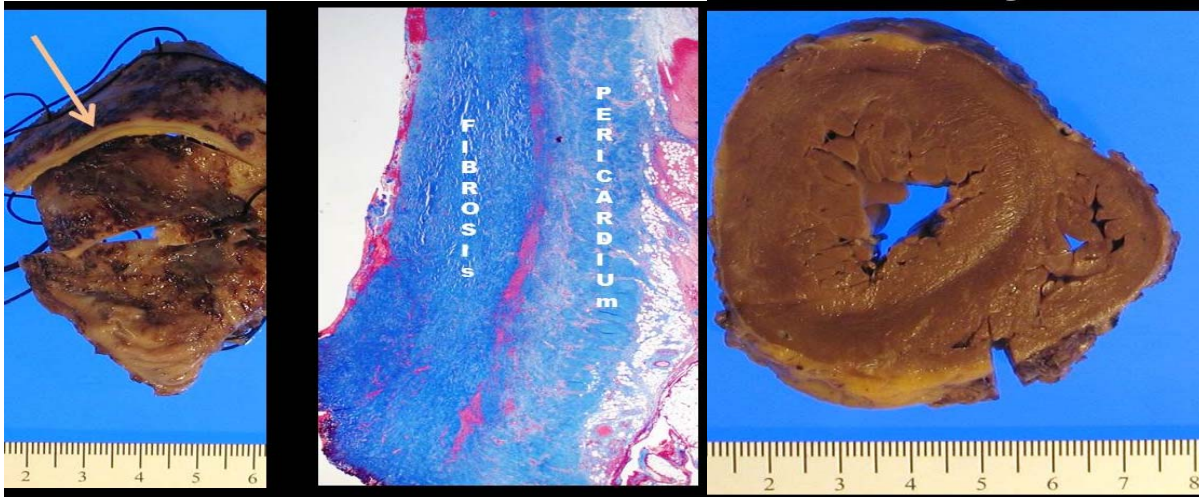
©2018 MFIMER | 3/12/2003-21

An e-mail from a junior staff
 52 year old man waiting for heart transplantation
 (had Echo, Cath, and MRI)



©2018 MFIMER | 3/12/2003-22

Explanted Heart

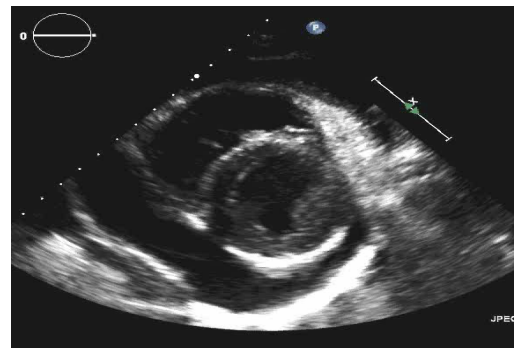


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Case # 1

27 yo man with fatigue and dyspnea

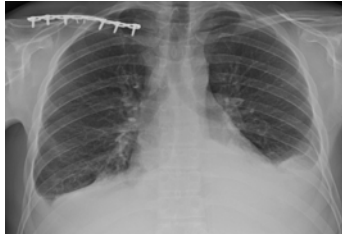
- Sep. 2015...Flu-like symptoms, treated with inhaler
- Oct. 2015...Pre-syncope and palpitation
 - Pericardial rub
 - Pericardial effusion on Echo
 - Treated with Ibuprofen 2400 mg/d
Colchicine 0.6 mg BID
- Not feeling better and CRP 60
- Underwent pericardial window



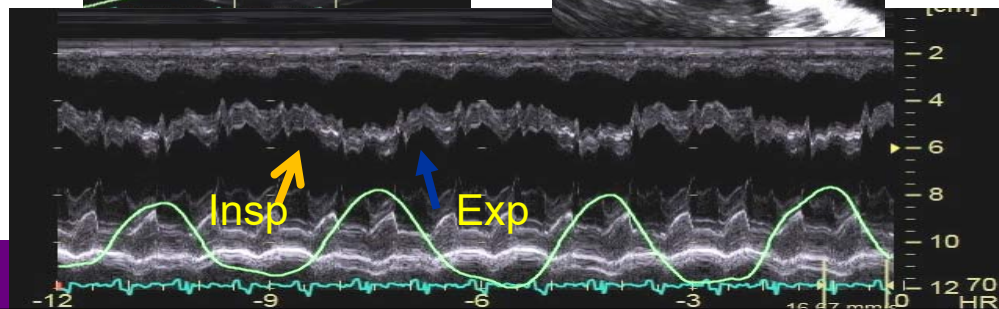
©2018 MFMER | 3712003-24

27 year old man underwent a window *Referred to Mayo*

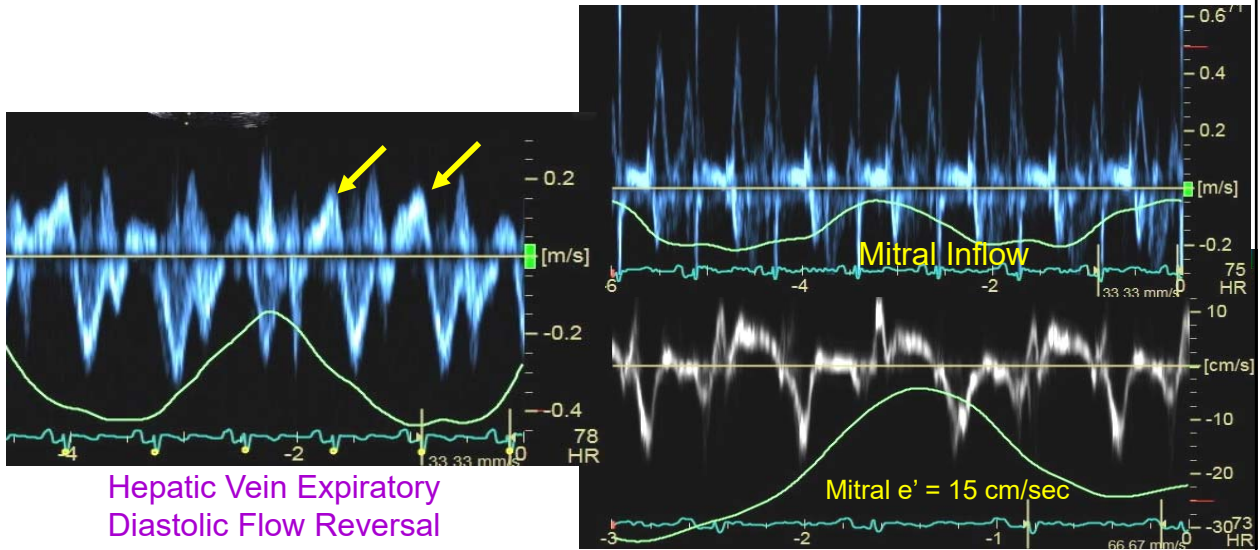
- Pericardial fluid ...studies were *negative*
- Not feeling better
- RUQ abdominal pain and fatigue
- U/S...Enlarged gallbladder and liver
- Consideration of cholecystectomy



Interventricular Dependence and IVC Plethora Constrictive Pericarditis



27 yo man after pericardial window

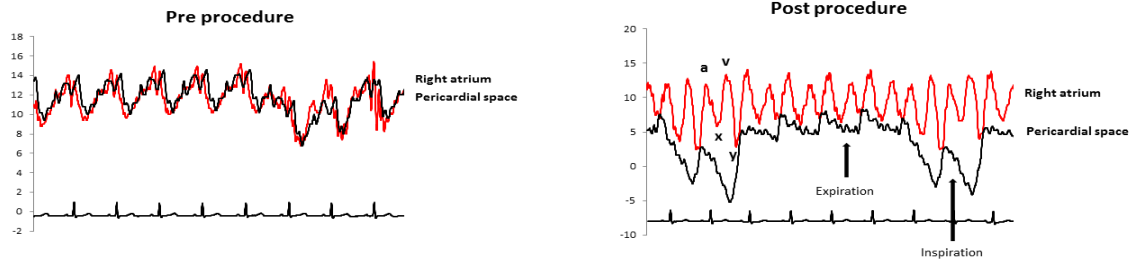


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Subacute Effusive-Constrictive Pericarditis

By E. W. HANCOCK, M.D.

Circulation, Volume XLIII, February 1971



Miranda et al. Heat 2015



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Effusive-Constrictive Pericarditis After Pericardiocentesis



Incidence, Associated Findings, and Natural History

Kye Hun Kim, MD,^{a,b} William R. Miranda, MD,^a Larry J. Sinak, MD,^a Faisal F. Syed, MBCrB,^a
Rowlens M. Melduni, MD,^a Raul E. Espinosa, MD,^a Garvan C. Kane, MD,^a Jae K. Oh, MD^a

- 205 consecutive patients with pericardiocentesis
- ECP was diagnosed in 33 (16%)
 - More frequent hemo-pericardium (33% vs 13%)
 - Higher % of neutrophils
 - Baseline medial mitral annulus e' higher
 - Expiratory diastolic flow reversal in HV more frequent
 - 2 required pericardiectomy in 3.8 year follow-up



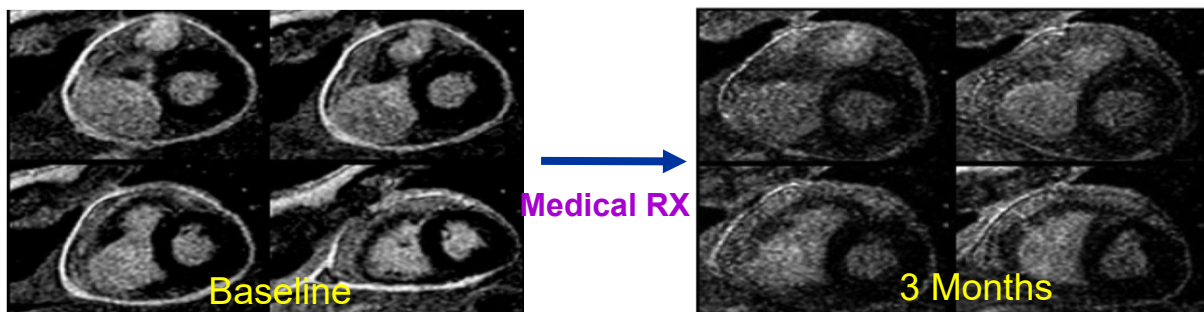
Kim KH, Miranda W, Oh JK et al JACC Imaging March 2018

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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; Kye-hun 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



Circulation Oct 3rd 2011

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Transient Constriction

Reversible (N=14) Persistent (N=15)

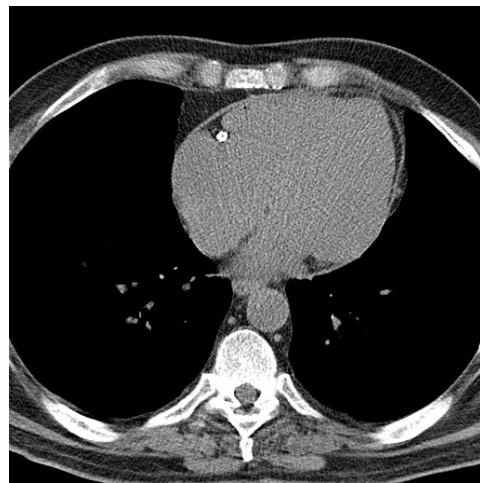
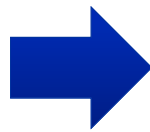
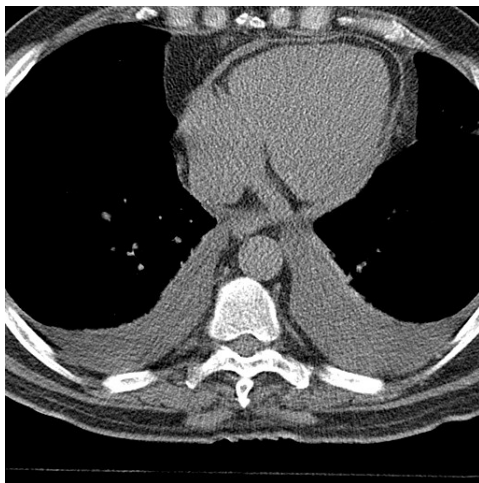
Age (yrs)	54 ± 17	59 ± 16
LVEF (%)	57 ± 3	60 ± 3
E' (cm/sec)	12 ± 1	11 ± 1
Steroid Rx	71 %	53 %
Pericardium	3.8 ± 0.6 mm	4.0 ± 0.6 mm
DE Pericardium	4.4 ± 0.4 mm	2.1 ± 0.4mm
Grade 3-4/4 DE	93 %	33 %
Sed rate	45 to 4	25 to 20
CRP	75 to 2	14 to 15



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Transient Constrictive Pericarditis

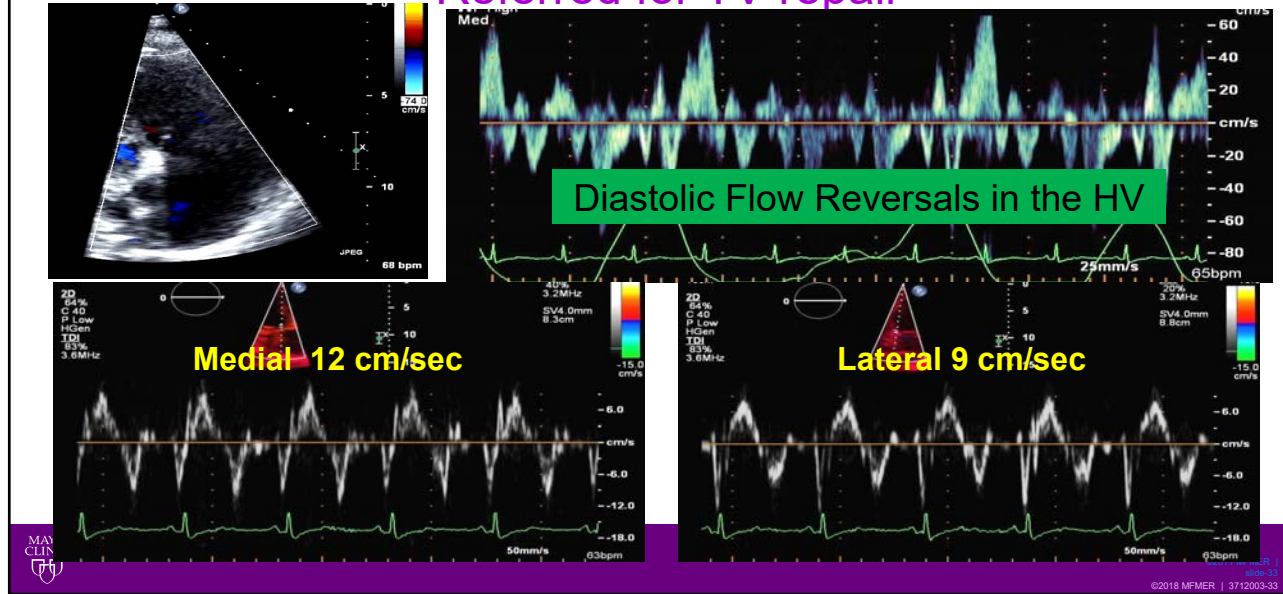
One week of Steroid Rx



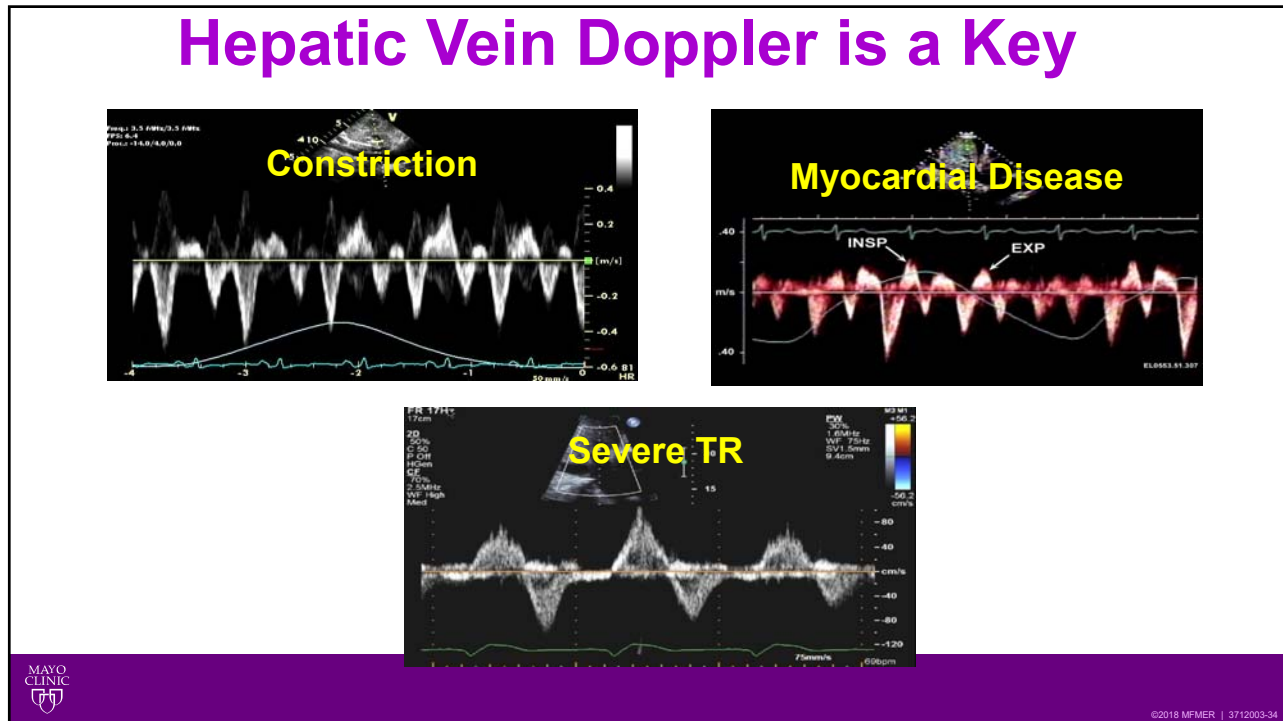
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Case #5

Heart failure with ascites and leg edema Referred for TV repair

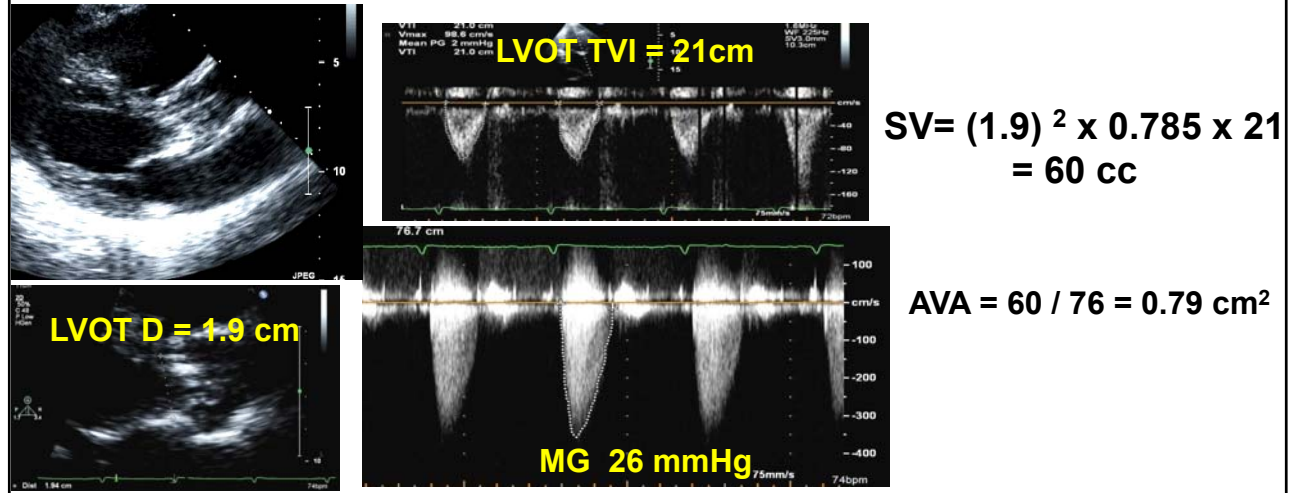


Hepatic Vein Doppler is a Key



67 year old man with severe AS came for AVR

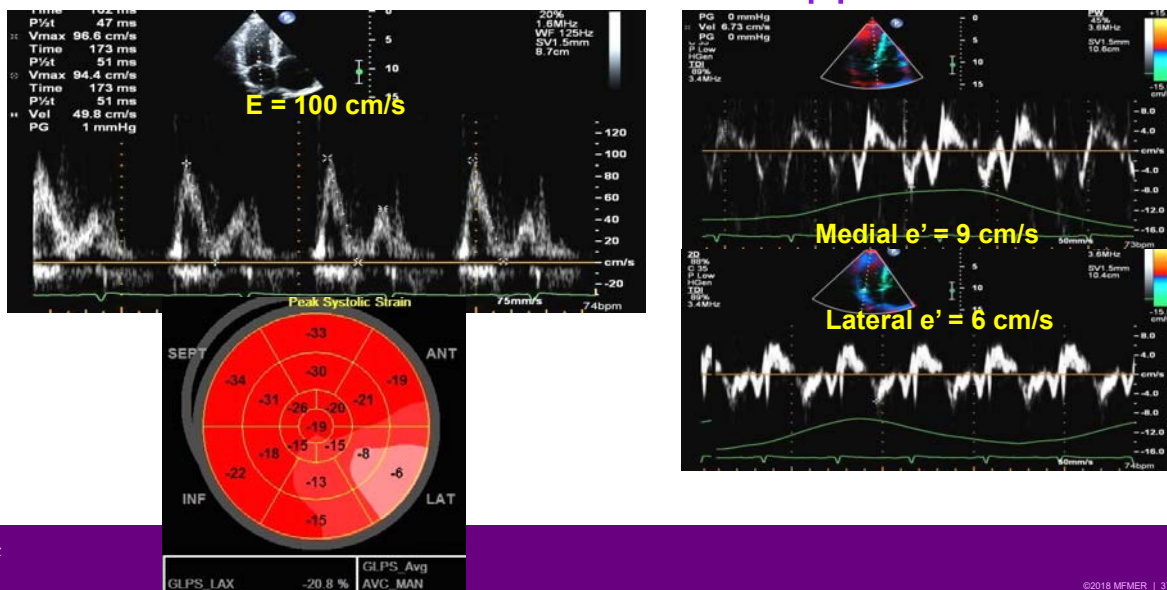
Low Flow Low Gradient AS



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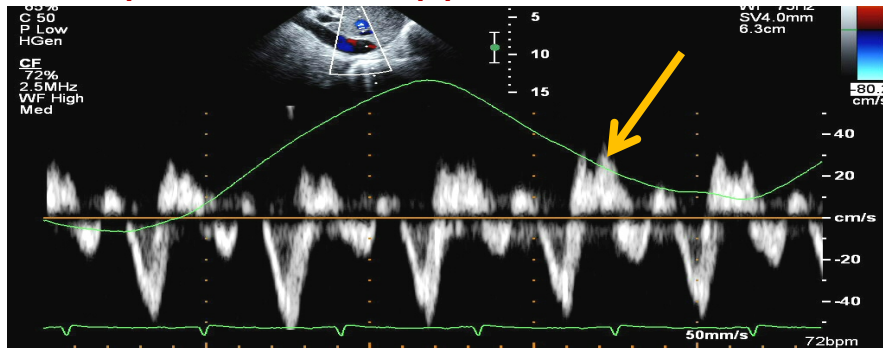
67 year old man with heart failure and LFLG AS

Mitral Annulus Tissue Doppler



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67 year old man with AS and Constriction Hepatic Vein Doppler c/w constriction



Radiation Heart Disease

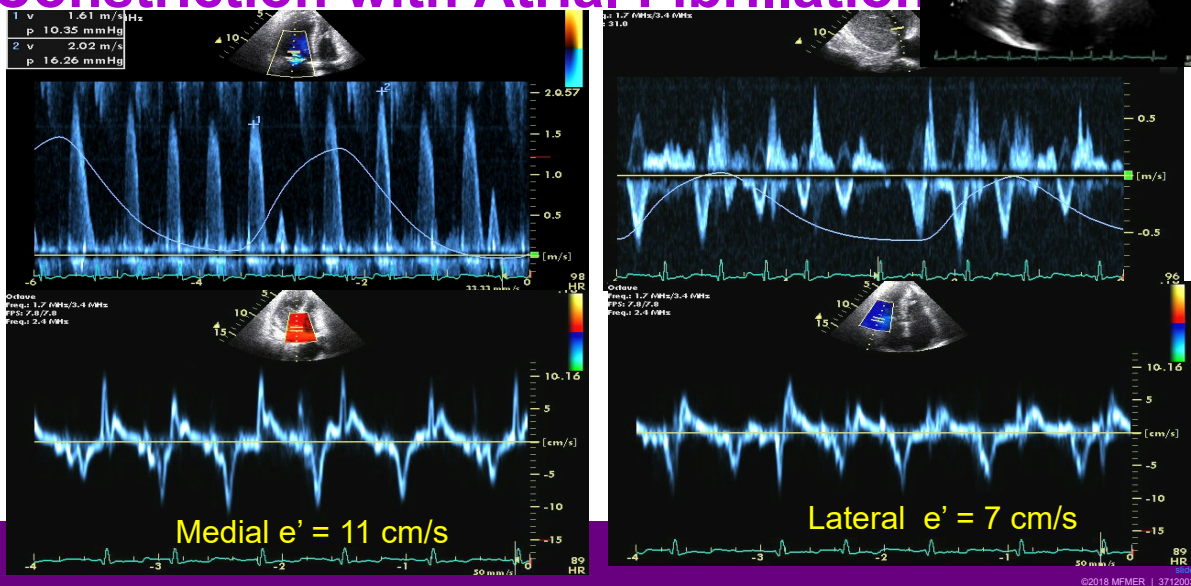
Valvular Heart Disease

Circulation CV Imaging 2015

Low-Flow, Low-Gradient Severe Aortic Stenosis in the Setting of Constrictive Pericarditis Clinical Characteristics, Echocardiographic Features, and Outcomes

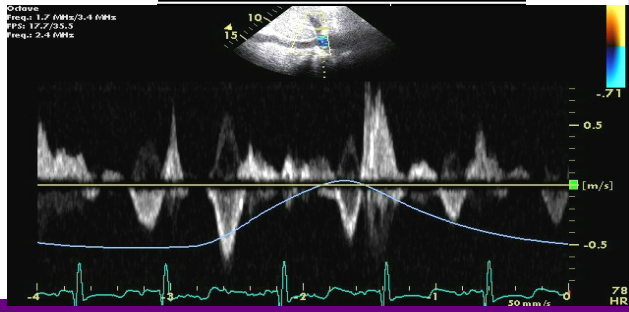
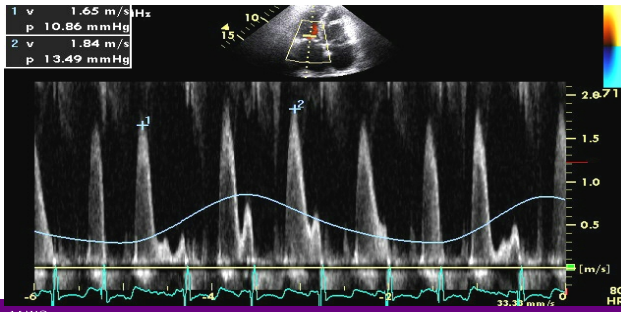
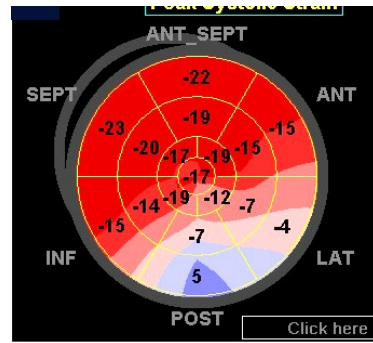
Michael Y.C. Tsang, MD; Jin-Oh Choi, MD, PhD; Barry A. Borlaug, MD;
Kevin L. Greason, MD; Stephen S. Cha, MSc; Rick A. Nishimura, MD; Jae K. Oh, MD

Constriction with Atrial Fibrillation



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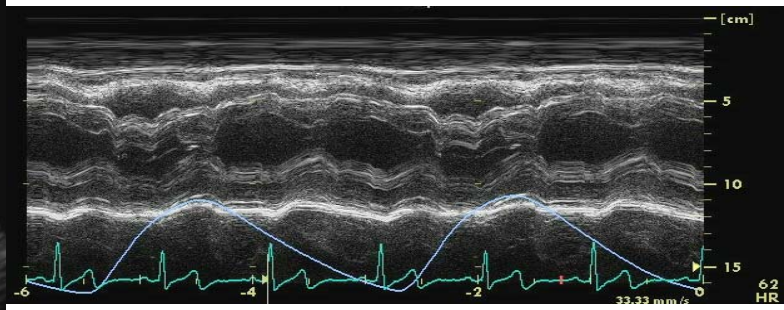
Constriction with A. Fibrillation After Cardioversion



©2011 MFEMER | slide-30
©2018 MFEMER | 3712003-30

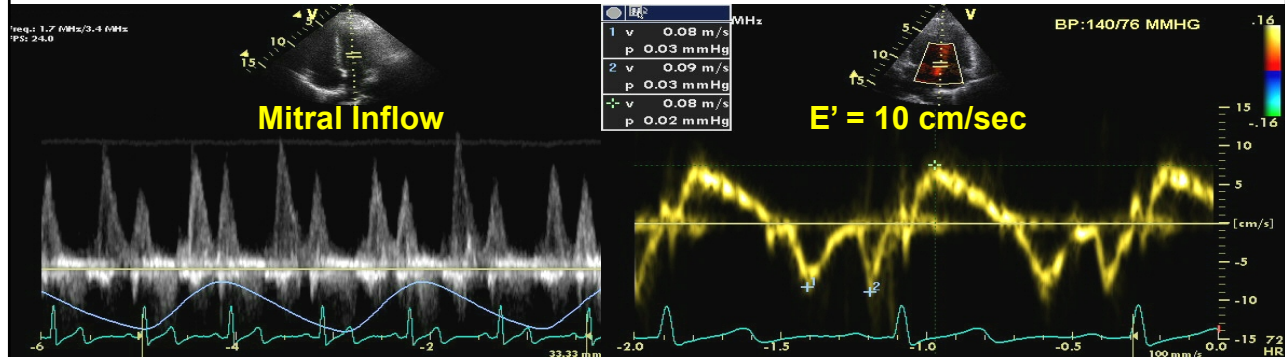
Case #2

A 27 yo woman with dyspnea Marked Septal Motion Abnormality



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A 27 yo woman with dyspnea Constrictive Pericarditis?

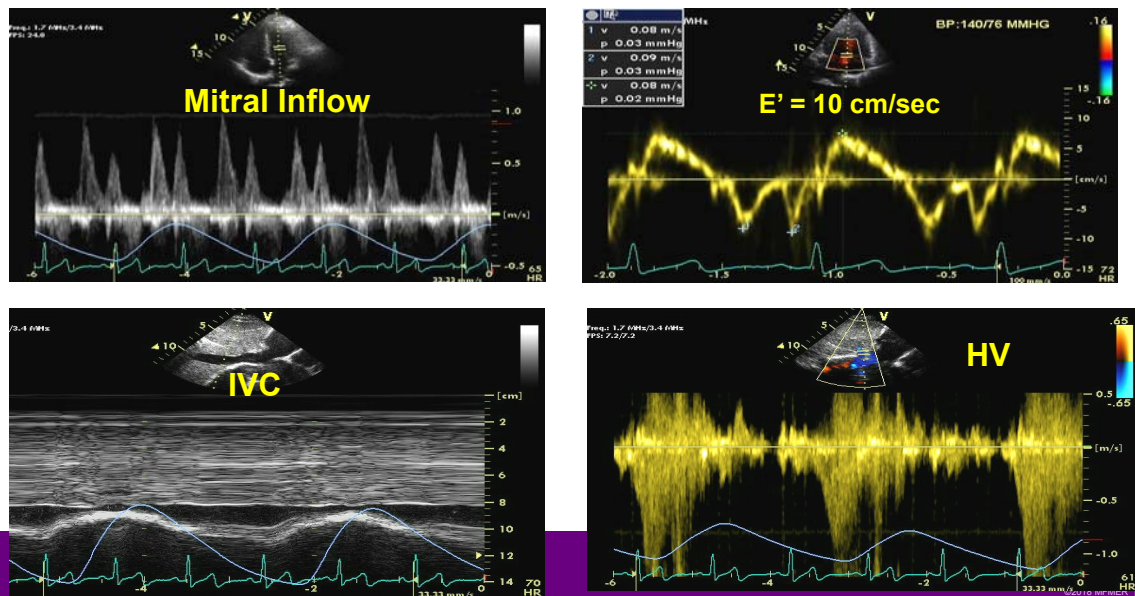


1. E' is increased
2. Septal motion abnormality
3. Mitral inflow variation



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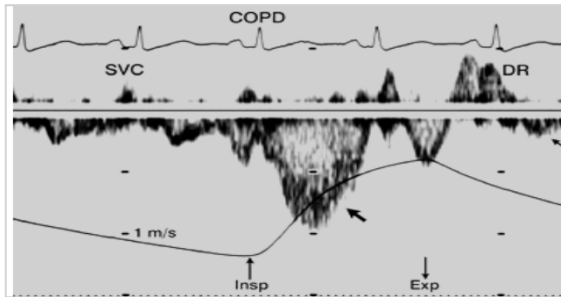
A 27 yo woman with dyspnea Pulsus Paradoxus with Asthma



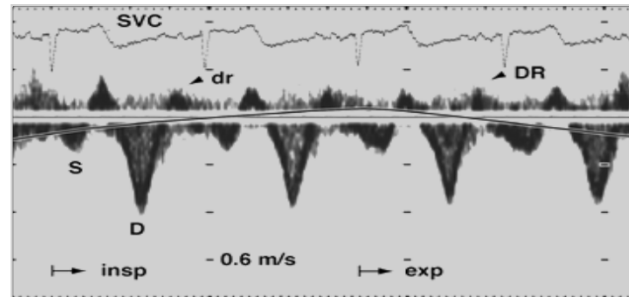
3712003-42

Constrictive vs COPD/Asthma SVC Flow Velocities

COPD



Constriction



Boonyaratavej S, et al. *J Am Coll Cardiol* 1998 Dec; 32 : 2043-8



CP983059-17
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Pericardiectomy at Mayo Clinic The first cardiac surgery in 1936

FEELS HEART BEAT AGAIN
Melbourne Man Has Stone Casing Cut Away at Mayo Clinic

ROCHESTER, Minn., July (AP).—Alick M. Watkins, 27, who came from Melbourne for surgical aid, walked out of a hospital here today able to feel his heart beat again after Mayo Clinic surgeons had cut away a half-inch casing of stone from that organ.

When he left Melbourne, March 17, physicians gave him only six months to live.

His father, Alick W. Watkins, told how a Mayo Clinic surgeon, performing the second pericardiectomy, worked at the calcified pericardium. The heart, with its hardened casing, was exposed for two hours, and four ribs resected in the operation which took four hours.

Alternately working three minutes and covering the organ with a warm cloth for three minutes, the surgeon lifted the heart out of the chest cavity part of the time the operation was in progress. Recovery from the relatively rare operation was rapid. Father and son will leave here next month for Melbourne.



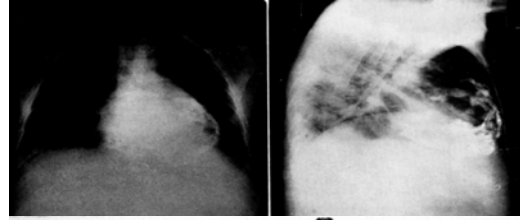
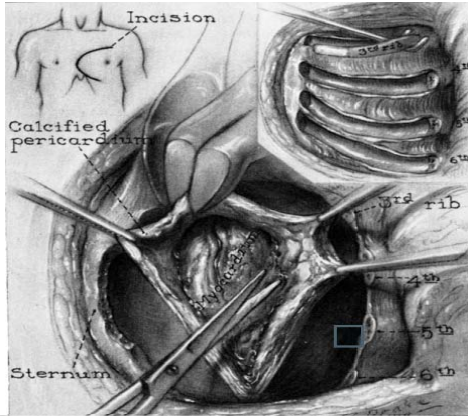
The New York Times
 Published: July 17, 1938
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Pericardiectomy at Mayo Clinic

The first cardiac surgery in 1936

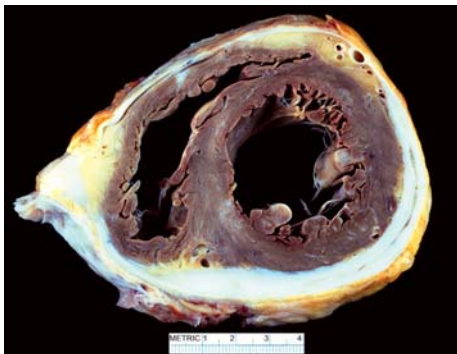


*Reprinted from The Southern Surgeon,
July, 1940, Vol. IX, No. 7, pp. 459-484*

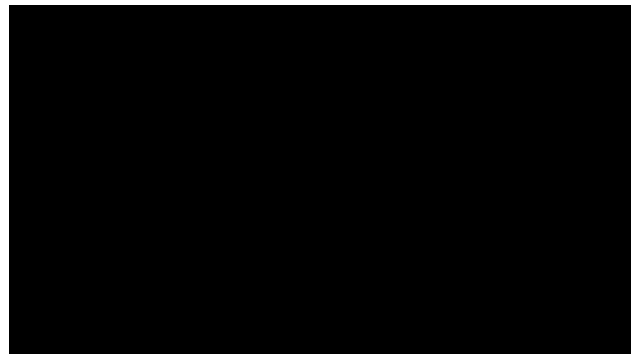


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Pericardiectomy



Courtesy of W. Edwards, MD

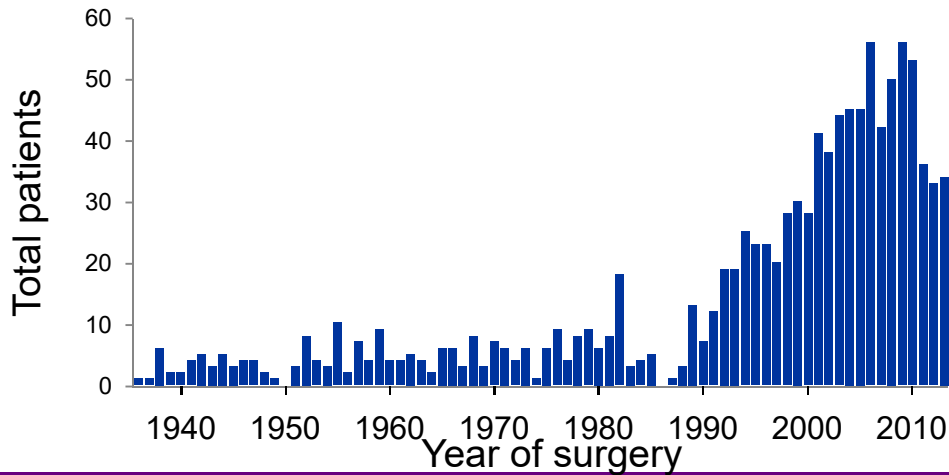


Courtesy of H. Schaff, MD



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



Murashita, Schaff, Greason et al Ann Thorac Surg 2017

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THE LANCET]

[SEPT. 7, 1935

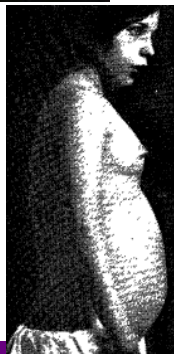
ADDRESSES AND ORIGINAL ARTICLES

CHRONIC CONSTRICTIVE PERICARDITIS (PICK'S DISEASE) TREATED BY PERICARDIAL RESECTION*

BY PAUL D. WHITE, M.D. Harvard
FROM THE MASSACHUSETTS GENERAL HOSPITAL, BOSTON, MASS.

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

The establishment of the diagnosis of CP has a three-fold importance



1. It affords the explanation of a group of symptoms and signs
2. It obviates confusion with other conditions
3. Expert thoracic surgery may now lead to cure what was once a hopeless disease



P.D. White The Lancet 1935

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Constriction vs Restriction Take Home Points

- **Dx of Constriction should be based on hemodynamics**
 - Restrictive mitral inflow with or without respiratory variation
 - Preserved or increased medial mitral e'
 - Respiratory variation of septal motion
 - Hepatic vein expiratory diastolic flow reversal
- **Under-diagnosed and mis-diagnosed**



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Pericardial Diseases Team Department of CV Diseases

Cardiology

- Nandan Anavekar, MD
- Raul Espinosa, MD
- Sharonne Hayes, MD
- Garvan Kane, MD
- Allen Luis, MD
- Rowlen Melduni, MD
- William Miranda, MD
- Jae Oh, MD

Cardiac Surgery

- Kevin Greason, MD
- Hartzell Schaff, MD
- Joseph Dearani, MD
- John Stulak, MD
- *Rocky Daily, MD*

Cardiac Pathology

- Joseph Maleszewski, MD • CV Echo Lab

Rheumatology

- Eric Matteson, MD
- Kevin Moder, MD

Imaging

- Eric Williamson, MD
- Phillip Young, MD
- James Glockner, MD

Fellows (Old and Current)

- JW Ha, MD
- Michel Senni, MD
- Gabriella Veress, MD
- Lieng Ling, MD
- Smonporn Boonyaratavej, MD
- Terrence Welch, MD
- F. Syed, MD, KH Kim, MD
- Dali Feng, MD J. Haley, MD
- D. Talreja, MD C. Tei, MD
- WM Soo, MD JH Yang, MD
- J. Dal-Bianco, MD G. Achyraya, MD



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Questions & Discussion

