Echo Doppler Evaluation of Diastolic Dysfunction

- What is diastolic dysfunction
- What do echo Doppler studies evaluate
- How accurate are they
- Disease management and prognosis

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Diastolic Dysfunction in Heart Disease

Relaxation is impaired and the heart fills more slowly, asynchronously or only with an increase in filling pressure

Sarano Mayo
Diastolic Dysfunction: Cardiomyopathy, Hypertension, CAD, Systemic disease, Valvular

- Ischemia
- Impaired Ca++ handling
- Small end systolic volume
- LV hypertrophy
- Fibrosis/Infiltration

LV relaxation → LV stiffness
Exercise Ability and LV Filling in Hypertensive Patients

![Graph showing VO2 L/Min vs. PCP mmHg with categories for LVH and NO LVH]
Progression of Inadequately Treated Hypertension

LV mass index
Men 131 g/m²
Women 100 g/m²

Rx

Prevent LVH
Maintain normal diastolic function

AF/CVA
Evaluation of Diastolic Dysfunction
What Do We Want to Know

- Is relaxation impaired
- What are the filling pressures
- Etiology of diastolic dysfunction
- Disease severity and prognosis
LV Filling Pressures: Mean LAP, LVEDP

LV

LA

LV+LA

LV

LA

LV RFW

LV pre-A

LV min

LVEDP

A-wave

V-wave

A-wave

Mean LAP

LA

LV
Patterns of MV Inflow

NORMAL

DELAY RELAX.
(normal LVFP)

HIGH LA PRESSURE
55 year old woman with untreated hypertension presents with SOBOE: No CAD

Small LVES volume, normal EF, LVH

LVEDD 3.7cm: LVESD 2.0

IVS 17mm PW 16 mm
LVMI 120 g/m2 (N <100)
Impaired Relaxation

Mitral Inflow

PV flow

E  40 cm/sec  DT 325ms
A  62 cm/sec
E/A  .6

Dominant PV systolic flow
mean PCWP = 17 + 5.3EA - 0.11IVRT

Prospective Group

All Patients

Naqueh et al, Am J Cardiol 75: 1256, 1995
Effects of age of flow velocities
Integrated Approach: Normal Velocity

E/A > 1
PVs = PVd
Pva < .35m/s
Ea > .1m/s
E/Ea < 7
HCM: DT and Mean LAP

- DT is a poor predictor of LAP or LVEDP in HCM
- Impaired relaxation overwhelms changes in filling pressures
- Also inaccurate when systolic function normal

Nishimura et al. JACC 1996

DT 220; LAP 9 DT 220: LAP 14 DT 200: LAP 30
Unmasking Pseudonormalization
Normal Mitral Inflow with Pressure

- Post Valsalva E/A reversal
- Pulmonary Vein
  - Systolic blunting
  - PV A reversal > .35 m/sec
  - PV > MV atrial duration
- Tissue Doppler Annular E/Ea > 10
Valsalva Maneuvre: LVEDP Elevated

Baseline  Post Valsalva
LVEDP: Mitral A Duration

Higher LVEDP shortens mitral a duration

Appleton et al
LVEDP
PVa - Mitral A duration

\[ r = 0.73 \]

\[ p < 0.01 \]
MYOCARDIAL VELOCITIES BY TISSUE PW-DOPPLER

\[ \text{LAP} = \frac{E}{E_{a}} \times 1.25 + 1.9 \]

Nagueh et al 1997
MVO: Pseudonormalization

- E/A > 1.5
- E/Ea 18
- PVs 0.44
- 0.33
- 0.49
- 0.44
- 0.41
- 0.73
Apical HCM

Why is this patient symptomatic: EF>75%: No MR
Apical HCM

PV Inflow

MV

Annulus

LVEDP > 15 mm Hg

LA Pressure = E/Ea x 1.25 + 2

90/8 (11.2) x 1.25 + 2 = 17 mm Hg
Restrictive Physiology: Elevated LAP

- Usually associated with systolic dysfunction or myocardial fibrosis or infiltration
- Represents late stage in disease
- Associated with high mortality unless reverses with therapy
- If systolic dysfunction not present often requires PV flow and Tissue annular Doppler
Dilated Cardiomyopathy: No CHF

Normal filling pressures at rest
Prognostic Value of Transmitral Velocity in DCM: Effect of a Persistent Restrictive Pattern

- 110 pts with DCM before and after 3 months of treatment
- Mean follow-up: 41± 20mo
- Events: death/heart transplantation
- 3 groups:
  1A- persistent restrictive pattern (n = 24)
  1B- reversible restrictive pattern (n = 29)
  2 - nonrestrictive filling pattern (n = 57)
- Deceleration time at 3 months was more powerful in predicting mortality than at baseline

Pinamonti et al, JACC 1997;29:604
Prognostic Value of Mitral Velocity

*Persistent restrictive pattern in DCM*

Pinamonti et al, JACC 1997;29:604

Graph showing the percentage of patients (% pts) over time (Time) for Group 1A, Group 1B, Group 2, with a significant difference indicated by p<0.0001.
85 year old man with previous Ant and Inf MI and inoperable triple vessel CAD presents with a 3 month history of increasing shortness of breath on exertion and ankle edema.
Calculation of PCWP

Mean PCWP = 17 + 5.3 E/A – 0.11 IVRT

17 + 15.9 – 8.8 = 24.1 mmHg
Treating CHF:

Increased ACE, Diuretics, Nitrates, low dose beta blocker
Treating CHF: Mitral and PV Flow

PRE
MV
E 119
A 31
E/A 2.6

POST
PV
E 80
A 80
E/A 1
Treating CHF

- Mild reduction in LV size
- Mild increase in systolic function (EF)
- Marked decrease in LV filling pressures
  - LVEDP, LAP, RVSP
- Marked decrease in MR
55 year old woman with CHF referred for evaluation of HCM
Cardiac Amyloidosis

Prognosis worse when:
- LV thickness > 14mm
- Restrictive physiology
- LV dysfunction
Quantitating LV Filling Pressures

- **What do Echo-Doppler studies measure**
  - LV Pre A (Mean LAP), LVEDP
- **Integrated approach to quantitation**
  - Mitral inflow
  - Pulmonary vein flow
  - Tissue Doppler annular velocities (newer equipment)
  - Use of Valsalva
- **Understanding limitations**
  - Hypertrophic cardiomyopathy
  - Normal LV function
  - Effects of age, loading conditions
  - Technical factors
Echo Doppler Evaluation of Diastolic Function

- Assessing diastolic function requires an integrated approach of MV, PV, Tissue Doppler
- Diastolic dysfunction is an important cause of symptoms in many cardiac diseases
- CHF often is due to diastolic dysfunction alone or complicating systolic dysfunction
- Echo-Doppler studies can accurately evaluate impairment of relaxation and filling pressures but requires an understanding of uses and limitations