SNS COLLEGE OF ALLIED HEALTH SCIENCE

Affiliated to The Tamil Nadu Dr. M.G.R Medical University, Chennai

DEPARTMENT OF CARDIAC TECHNOLOGY

COURSE NAME : ECHOCARDIOGRAPHY

UNIT : SEGMENTAL ANALYSIS AND HEMODYNAMIC ASSESSMENT

TOPIC : ECHO ASSESSMENT OF LV DIASTOLIC DYSFUNCTION

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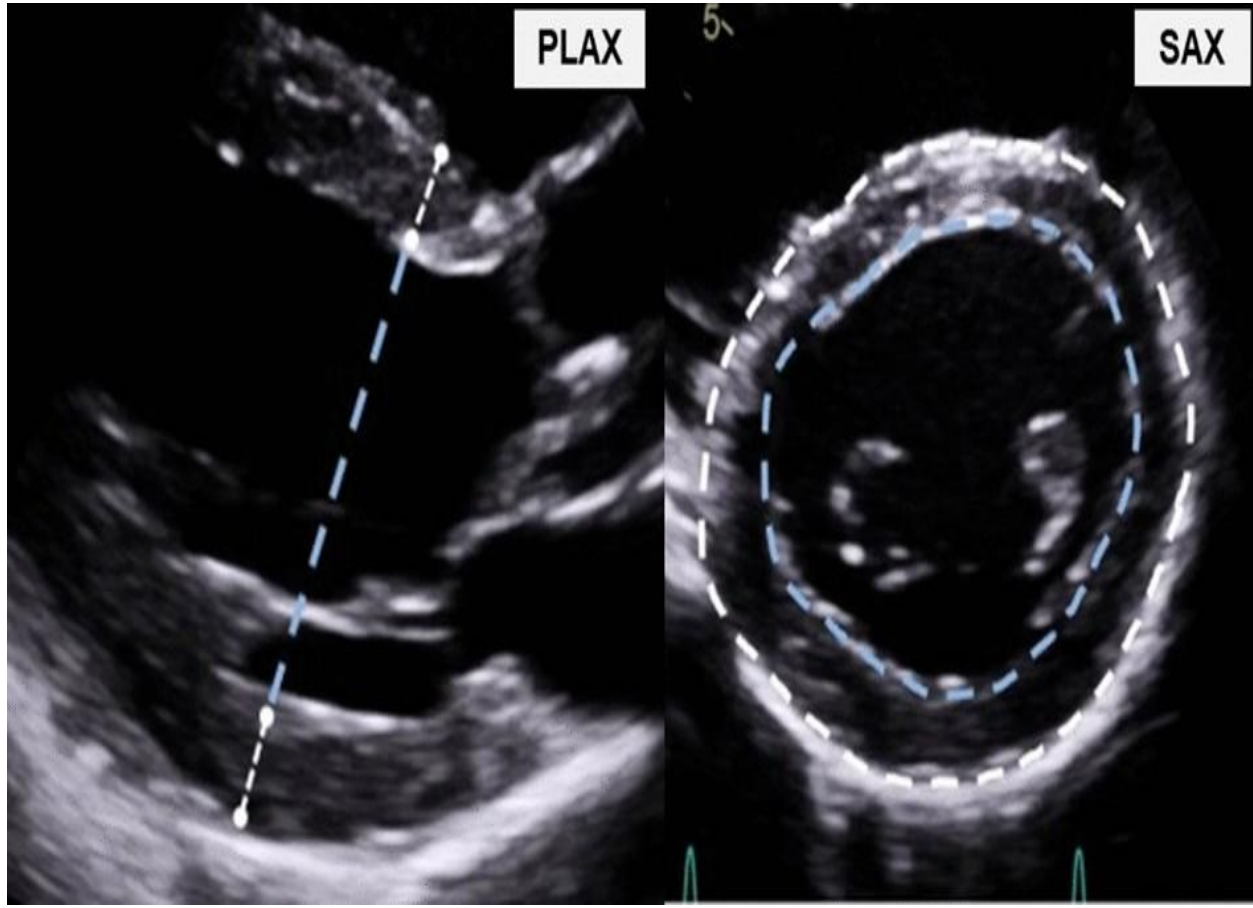
INTRODUCTION

Left Ventricular Diastolic Function refers to the ability of the left ventricle (LV) to **relax, fill, and accommodate blood** during diastole at **normal or low filling pressures.**

It depends on **myocardial relaxation**, **chamber compliance**, and **left atrial–LV pressure relationships.**

Diastole consists of:

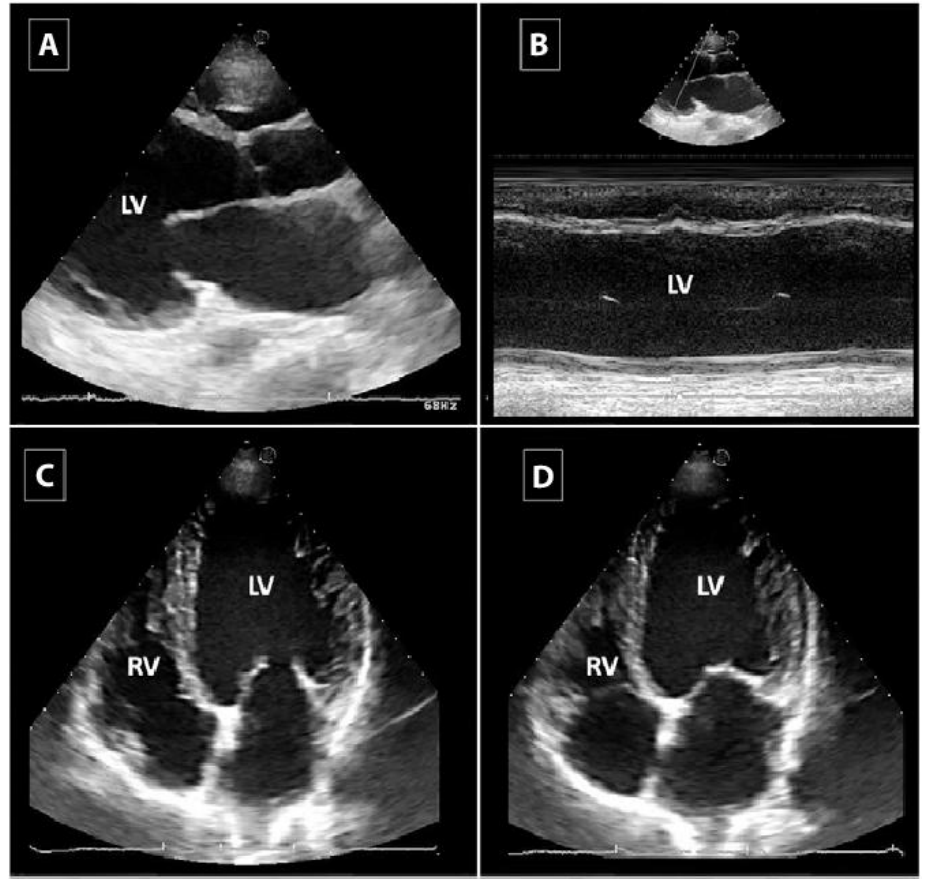
- ✓ **Isovolumic Relaxation**
- ✓ **Early Rapid Filling (E-wave)**
- ✓ **Diastasis**
- ✓ **Atrial Contraction (A-wave)**



Physiology

Normal diastolic filling requires:

- **Active LV relaxation** (energy-dependent)
- **Elastic recoil**
- **Normal LV compliance**
- **Low LV filling pressures**
- **Intact LA function**
- Impairment in any step → **diastolic dysfunction**.



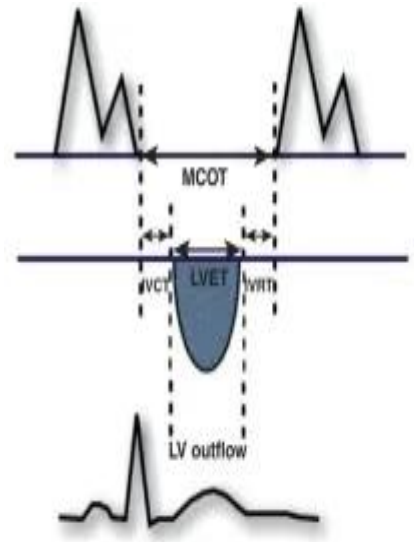
Physiology

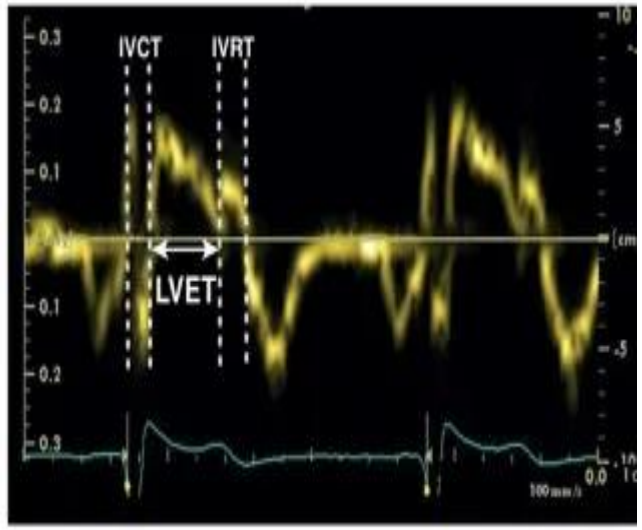
1. Isovolumic Relaxation Time (IVRT)

a. Begins after aortic valve closure (S2)

b. LV pressure falls rapidly

c. No change in volume





2. Early Rapid Filling (E-wave)

a. Mitral valve opens

b. Passive suction and pressure gradient drive blood into LV

c. Influenced by **relaxation** and **elastic recoil**

$$\text{LV MPI} = \frac{\text{IVCT} + \text{IVRT}}{\text{LVET}} = \frac{\text{MCOT} - \text{LVET}}{\text{LVET}}$$

Physiology

3. Diastasis

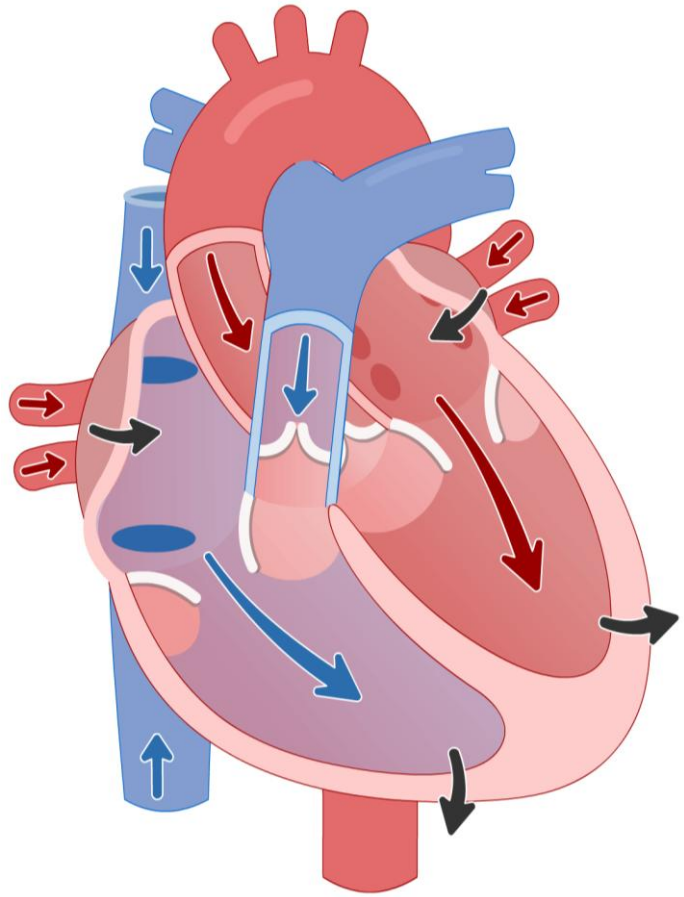
a. Equalization of LA–LV pressures

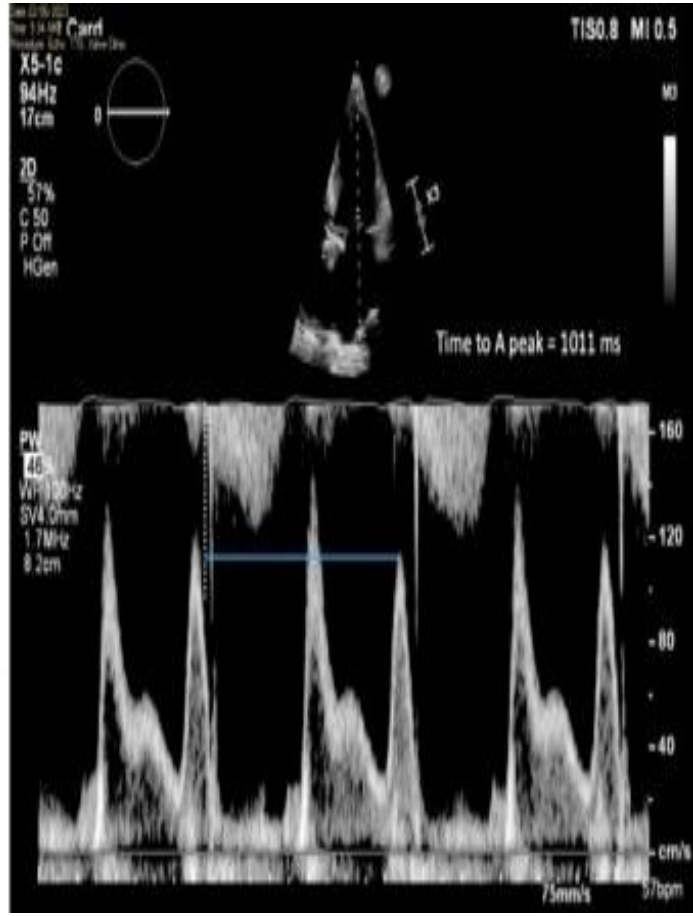
b. Minimal filling occurs

4. Atrial Contraction (A-wave)

a. Active filling occurs due to atrial systole

b. Contributes 20–30% of total filling (↑ with aging)





Methodology for Diastolic Function Assessment

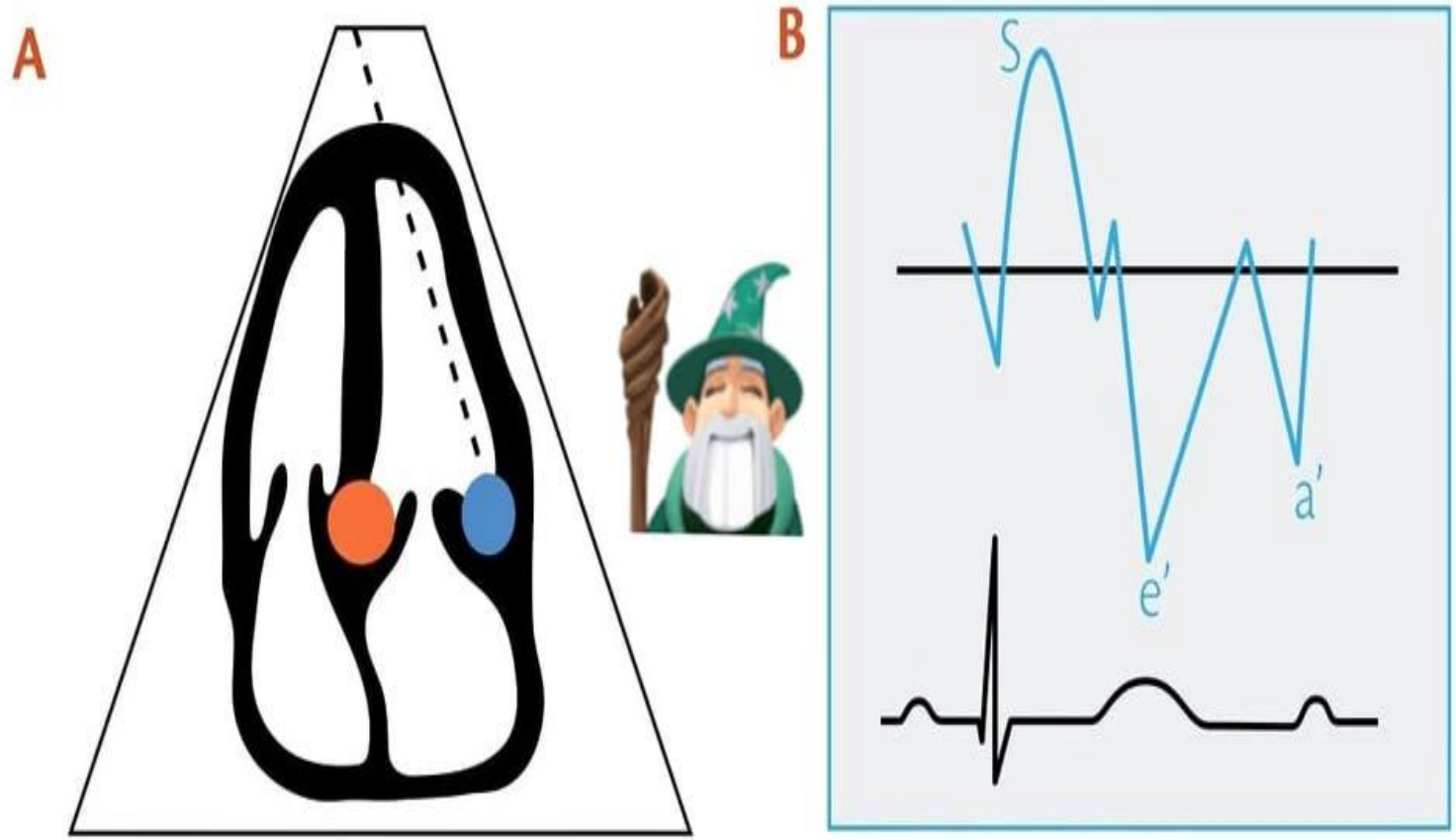
A. Mitral Inflow Doppler (PW Doppler)

Probe position: **Apical 4-chamber**,

sample volume at leaflet tips

Measurements:

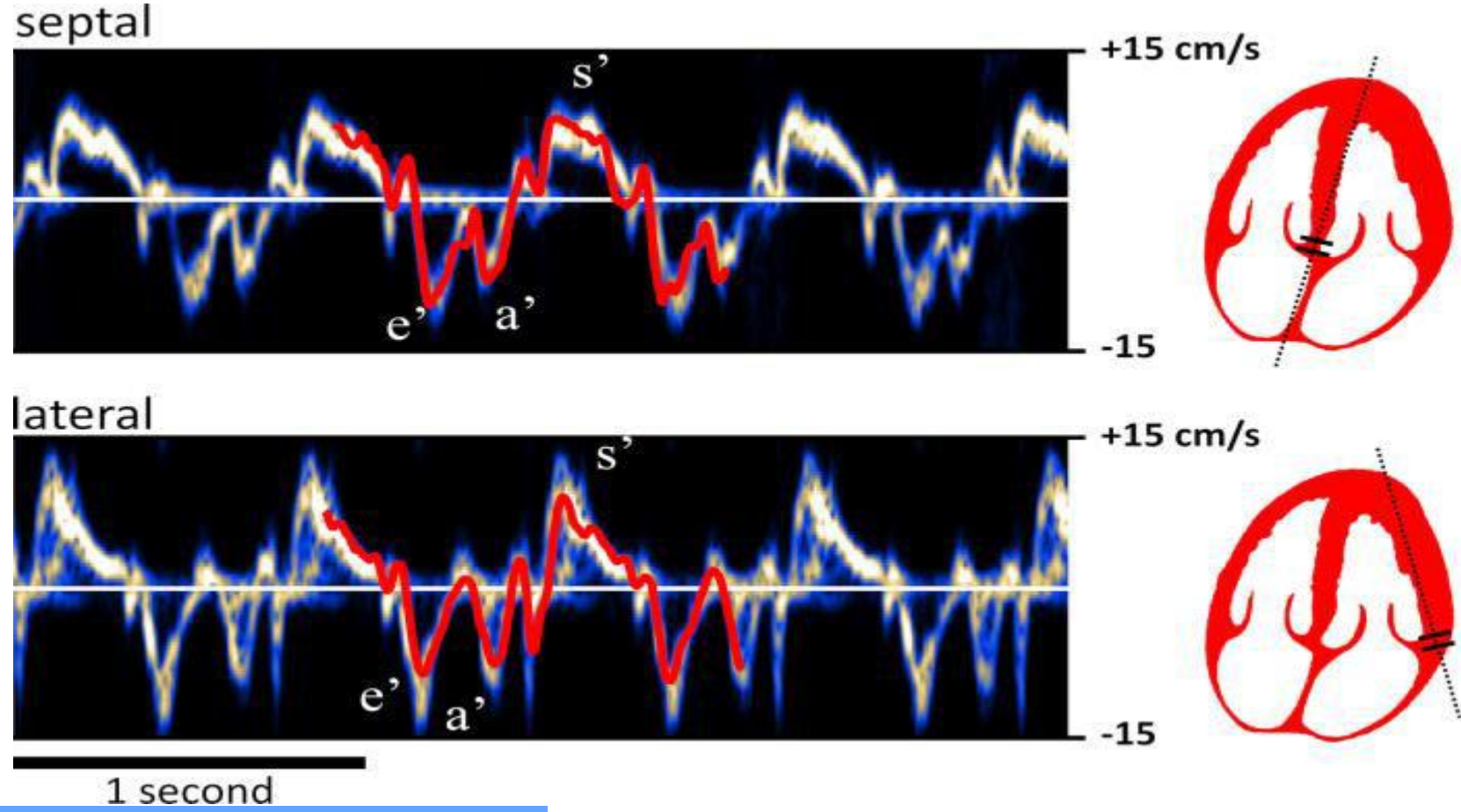
1. E-wave velocity (early filling)
2. A-wave velocity (atrial contraction)
3. E/A ratio
4. Deceleration Time (DT)



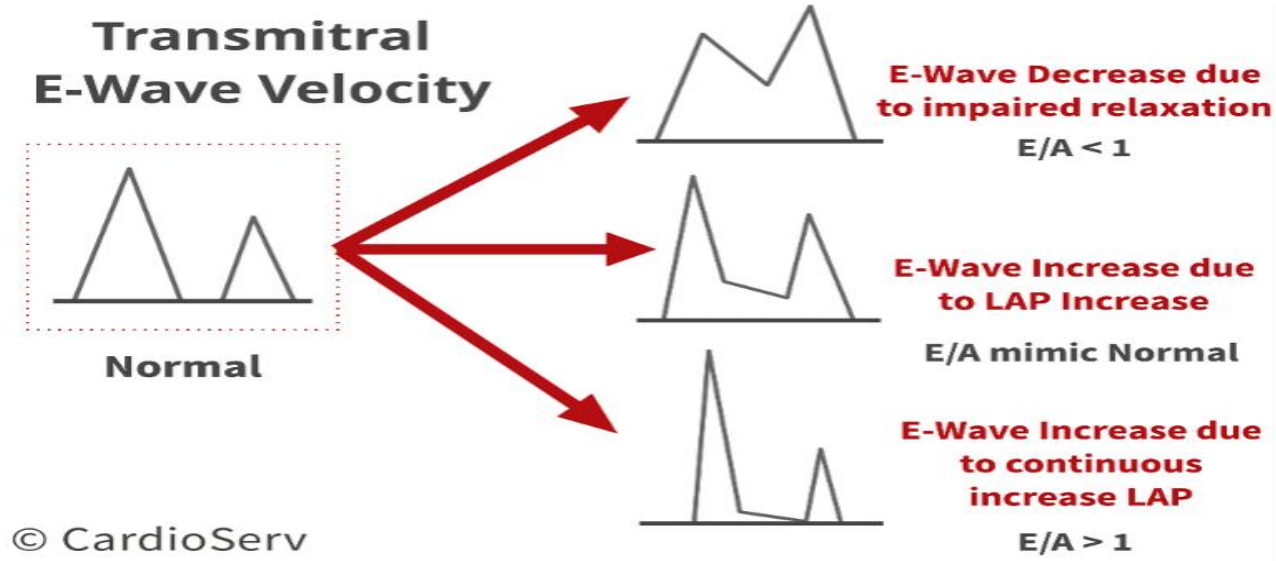
Methodology for Diastolic Function Assessment

B. Tissue Doppler Imaging (TDI) – Mitral Annular e′

a. Location:
b. Septal e′
c. Lateral e′
   Calculate **average e′**.



Methodology for Diastolic Function Assessment



C. E/e′ Ratio

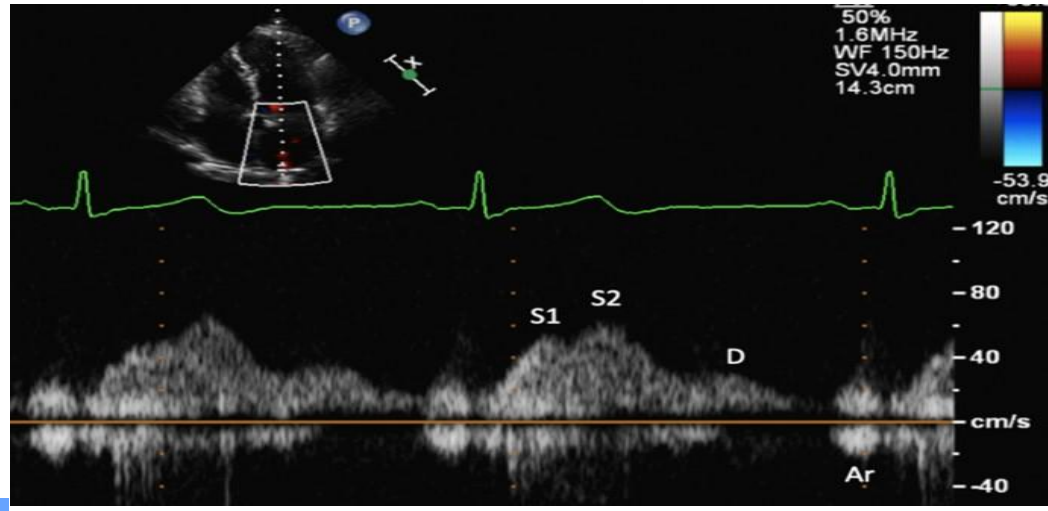
a. Reflects LV filling pressures

b. E (mitral inflow) ÷ e′ (TDI)

D. Left Atrial Volume Index (LAVI)

a. Biplane method of disks

b. Reflects **chronic LV filling pressure**

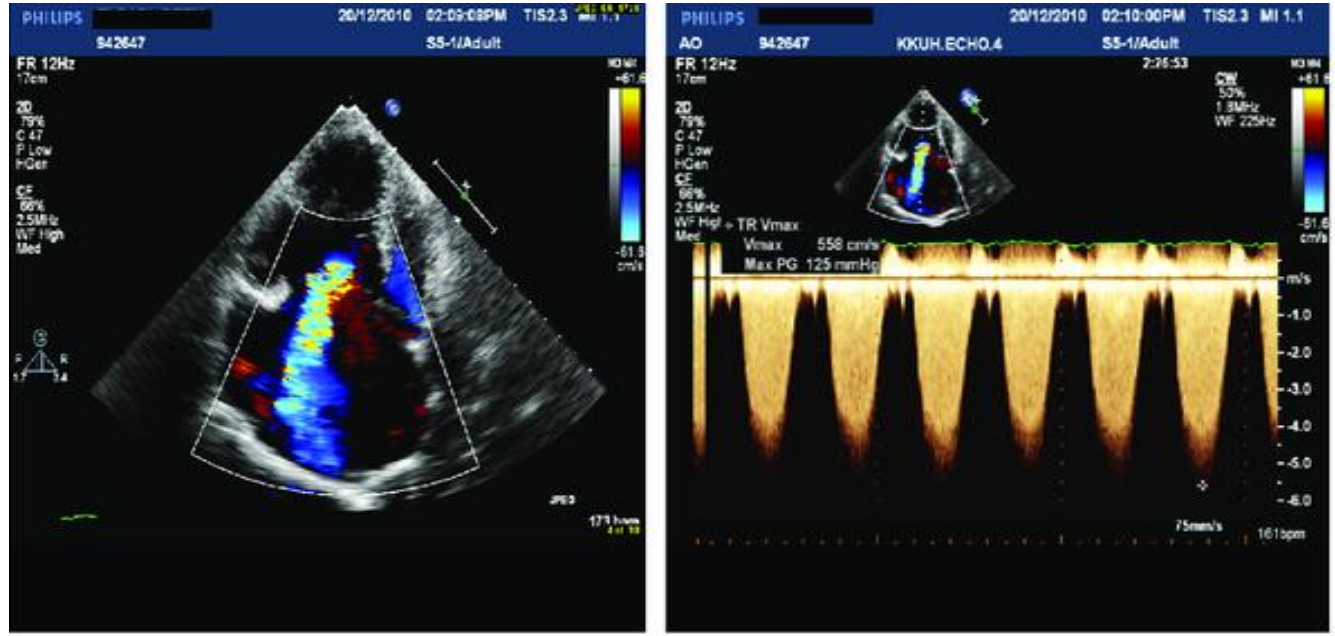


Methodology for Diastolic Function Assessment

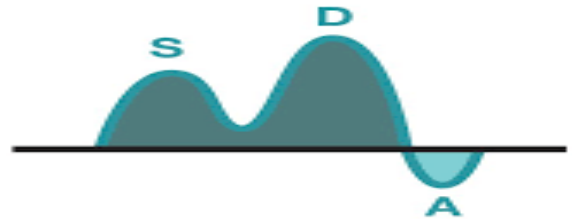
E. Tricuspid Regurgitation Velocity (TR Vmax)

a. Reflects pulmonary artery systolic pressure

b. ↑ TR velocity suggests ↑ LA pressure



Blunted Systolic Flow



F. Pulmonary Vein (PV) Doppler

a. Systolic (S) and Diastolic (D) flow

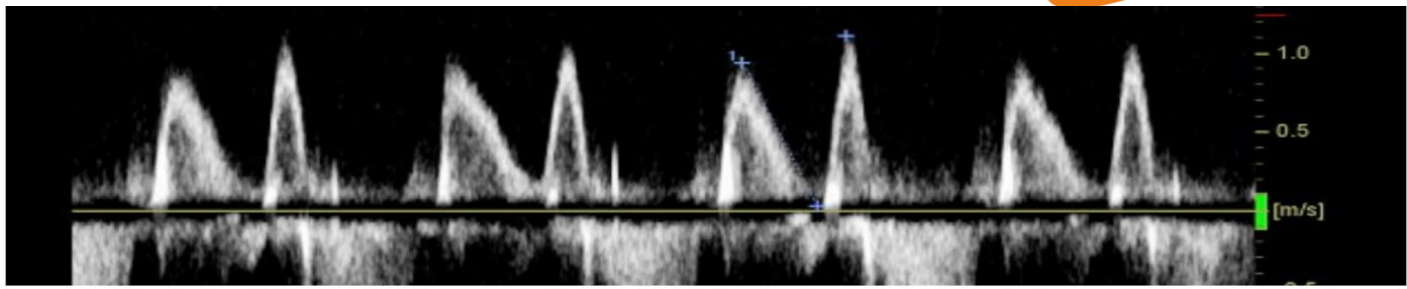
b. Ar–A duration (atrial reversal)

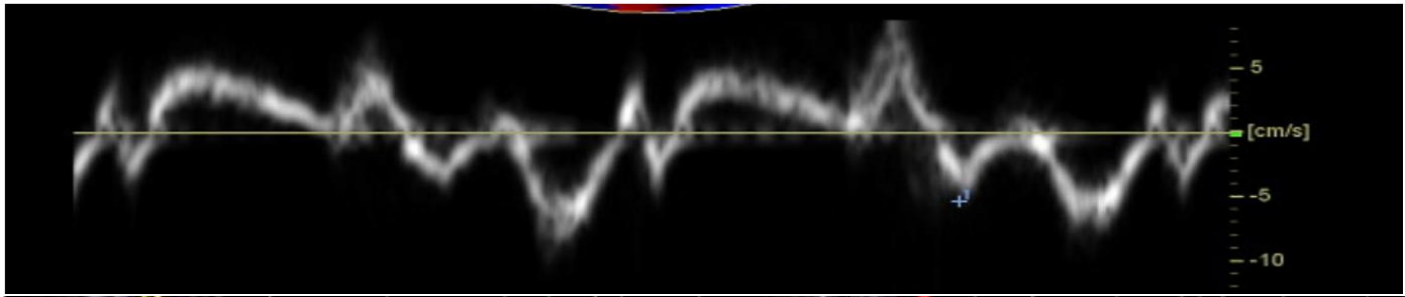
Methodology for Diastolic Function Assessment

G. IVRT (Isovolumic Relaxation Time)

a. Prolonged in impaired relaxation

b. Short in restrictive filling

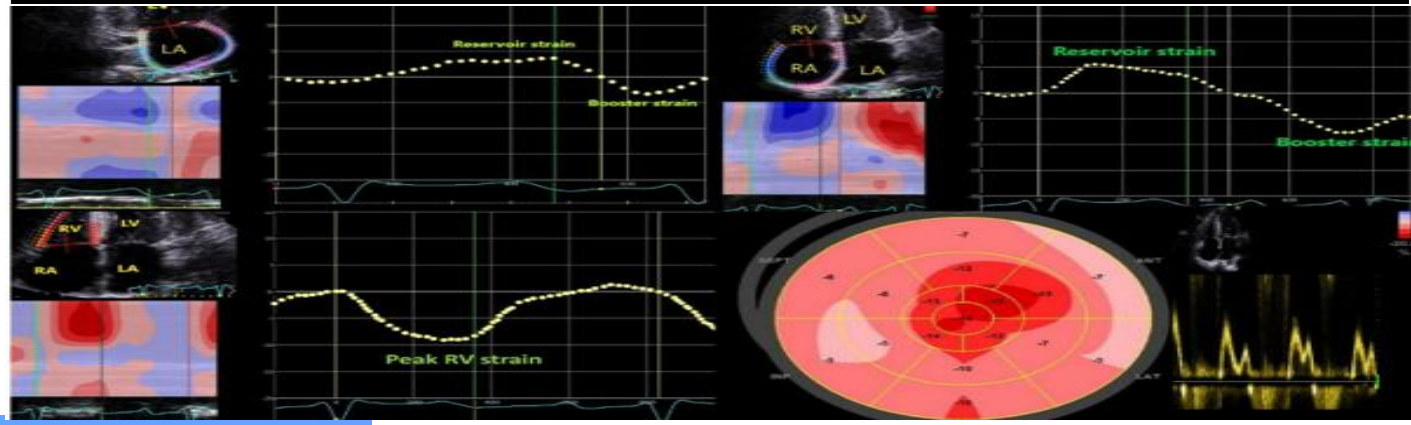




H. Strain Imaging (optional)

a. LA reservoir strain

b. LV strain patterns in HFpEF



Important Parameters and Interpretation

A. Mitral Inflow Patterns

Pattern	E/A Ratio	E velocity	DT	Meaning
Normal	1–2	Normal	160–240 ms	Normal relaxation
Grade I – Impaired relaxation	<0.8	Low	Prolonged	Low early filling
Grade II – Pseudonormal	0.8–1.5	Normal	Normal	Elevated LAP masks impairment
Grade III – Restrictive	>2	High	<160 ms	Severe ↑ LAP, ↓ compliance

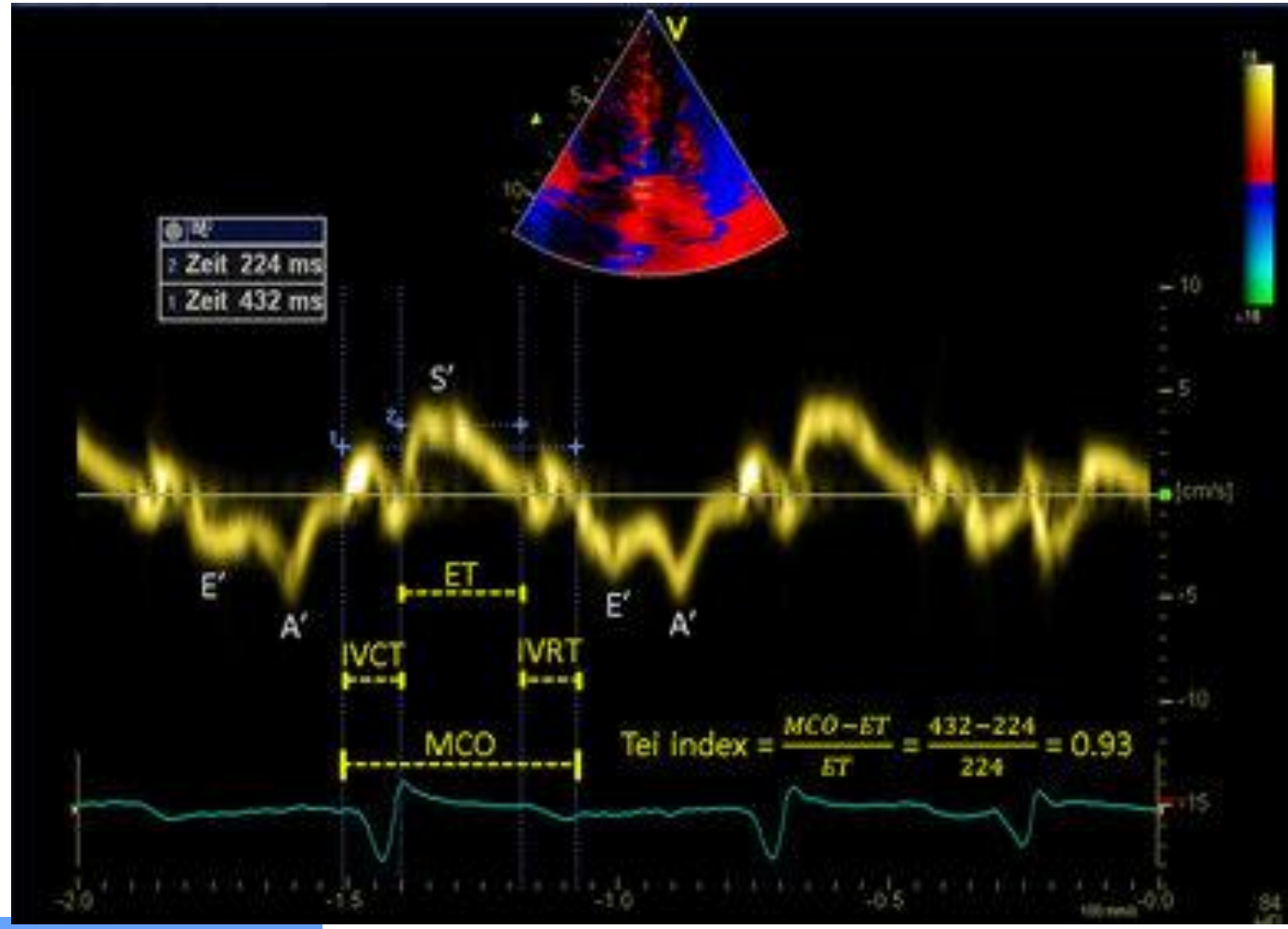
Important Parameters and Interpretation

Tissue Doppler Imaging

Parameter	Normal	Abnormal
Septal e′	>7 cm/s	<7 cm/s
Lateral e′	>10 cm/s	<10 cm/s
Average e′	>9 cm/s	<9 cm/s

E/e′ Ratio

Value	Interpretation
<8	Normal LAP
8–14	Indeterminate
>14	Elevated LAP



Important Parameters and Interpretation

LA Volume Index (LAVI)

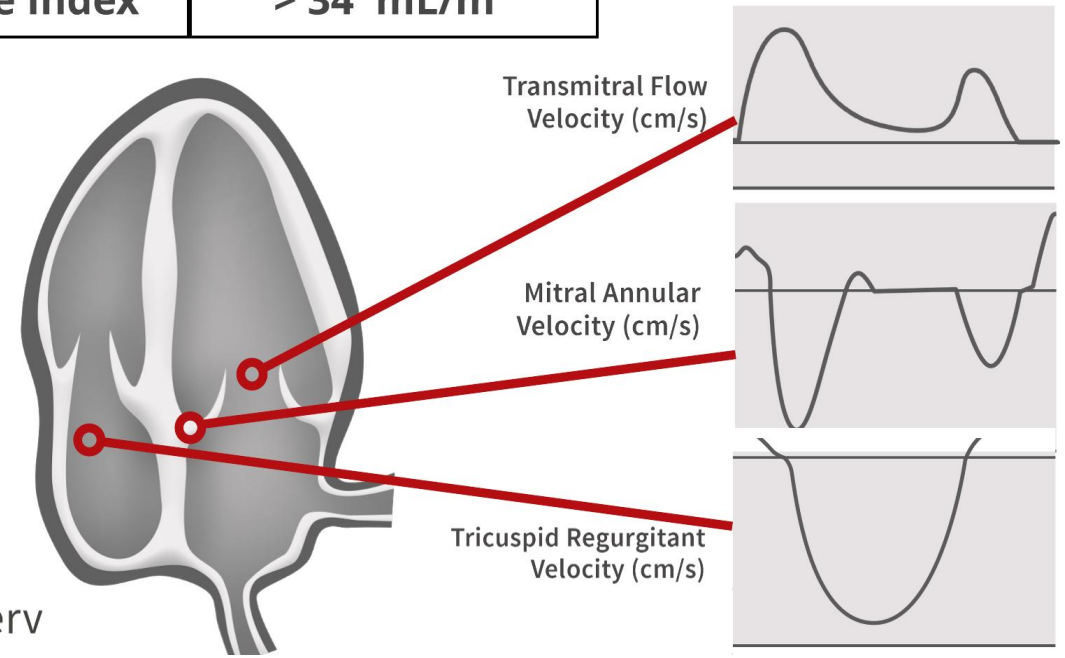
LAVI	Interpretation
<34 mL/m^2	Normal
>34 mL/m^2	Chronic elevation of LV filling pressures

TR Jet Velocity

TR Vmax	Meaning
≤2.8 m/s	Normal
>2.8 m/s	Elevated PAP due to ↑ LAP

Parameters	Cut-Off Value
Average E/e'	> 14
TR Velocity	> 2.8 m/s
LA Volume Index	> 34 mL/m^2

Non-Invasive Assessment LV Filling Pressures



Grading of LV Diastolic Dysfunction

STEP 1: Determine if LV diastolic function is normal or abnormal

Check 4 parameters:

a. Average e′ < 7–10 cm/s (reduced)

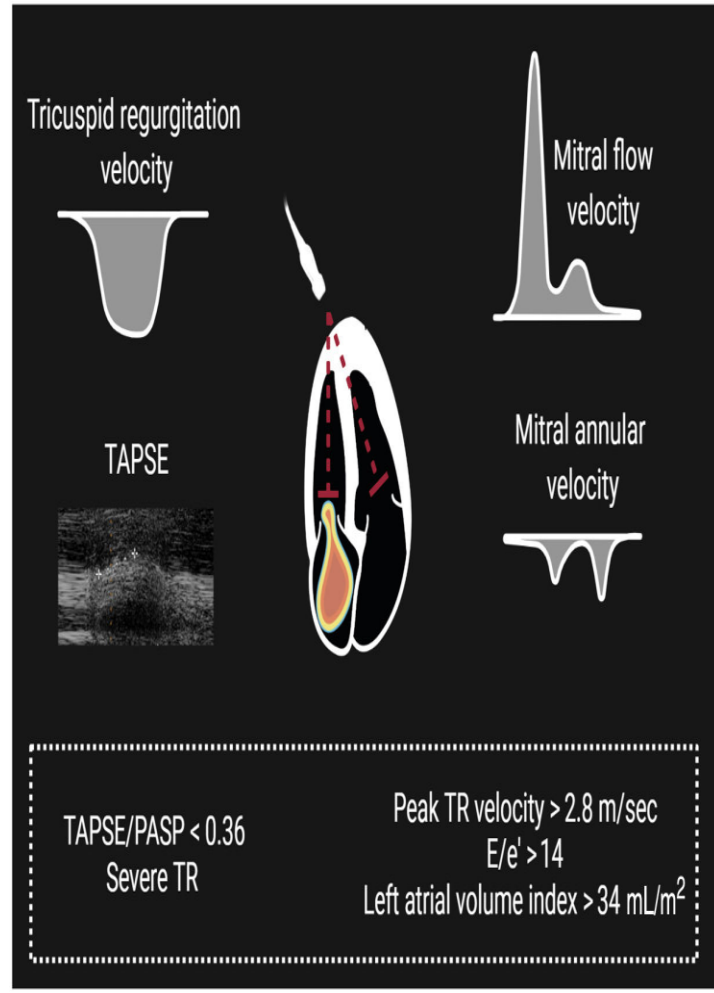
b. E/e′ > 14 (elevated filling pressure)

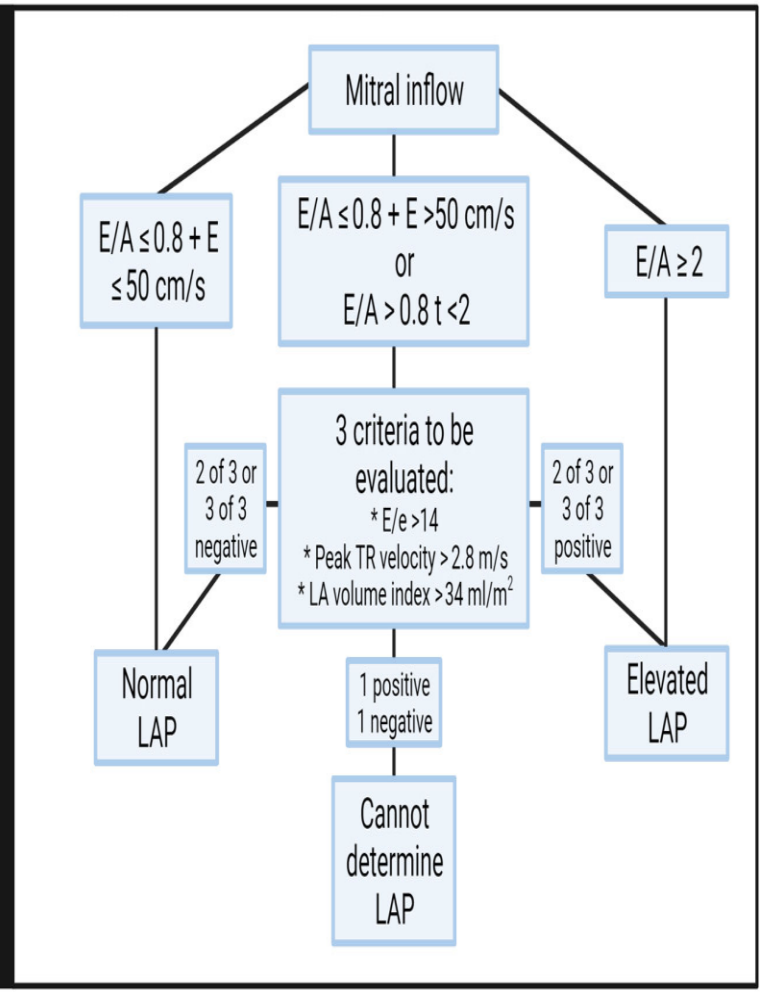
c. LA volume index > 34 mL/m^2

d. TR velocity > 2.8 m/s

≥2 abnormal → diastolic dysfunction present

≤1 abnormal → normal diastolic function





Grading of LV Diastolic Dysfunction

STEP 2: Grade the Diastolic Dysfunction

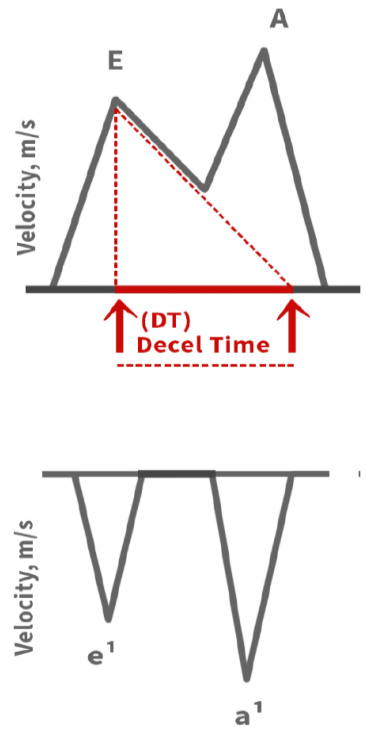
GRADE I: Impaired Relaxation

a. E/A < 0.8

b. E velocity < 50 cm/s

c. Normal or low LAP

d. LAVI normal or mildly ↑



1. E-Wave Velocity ≤ 50 cm/sec
2. E/A Ratio ≤ 0.8
3. DT > 220 ms
4. Normal LAP

Grading of LV Diastolic Dysfunction

GRADE II: Pseudonormal Filling

E/A 0.8–1.5

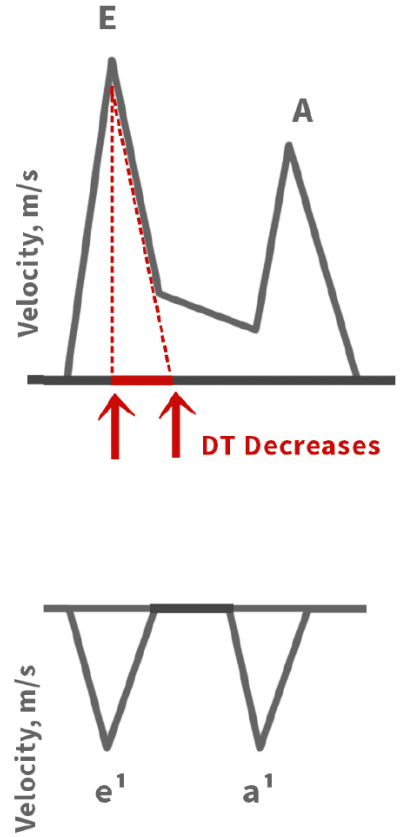
Normal-appearing mitral inflow

Supportive markers of ↑ LAP:

a. E/e′ > 14

b. LAVI > 34 mL/m²

c. TR Vmax >2.8 m/s



1. E/A Ratio > 0.8 but < 2
2. E/e' Ratio > 14
3. Decreased e' velocity
4. Valsalva Maneuver E/A Reduced > 50%
5. Increased LAP

Grading of LV Diastolic Dysfunction

GRADE III: Restrictive Filling

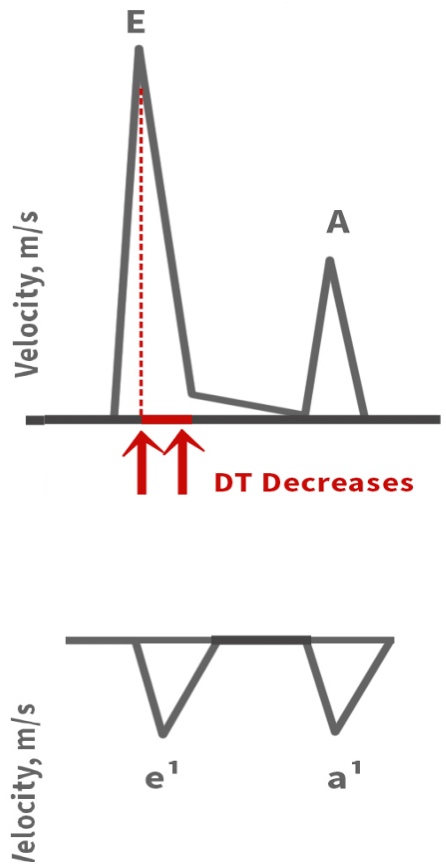
E/A ≥ 2

DT ≤ 160 ms

High E velocity

LAVI significantly ↑

Markedly ↑ LV filling pressures

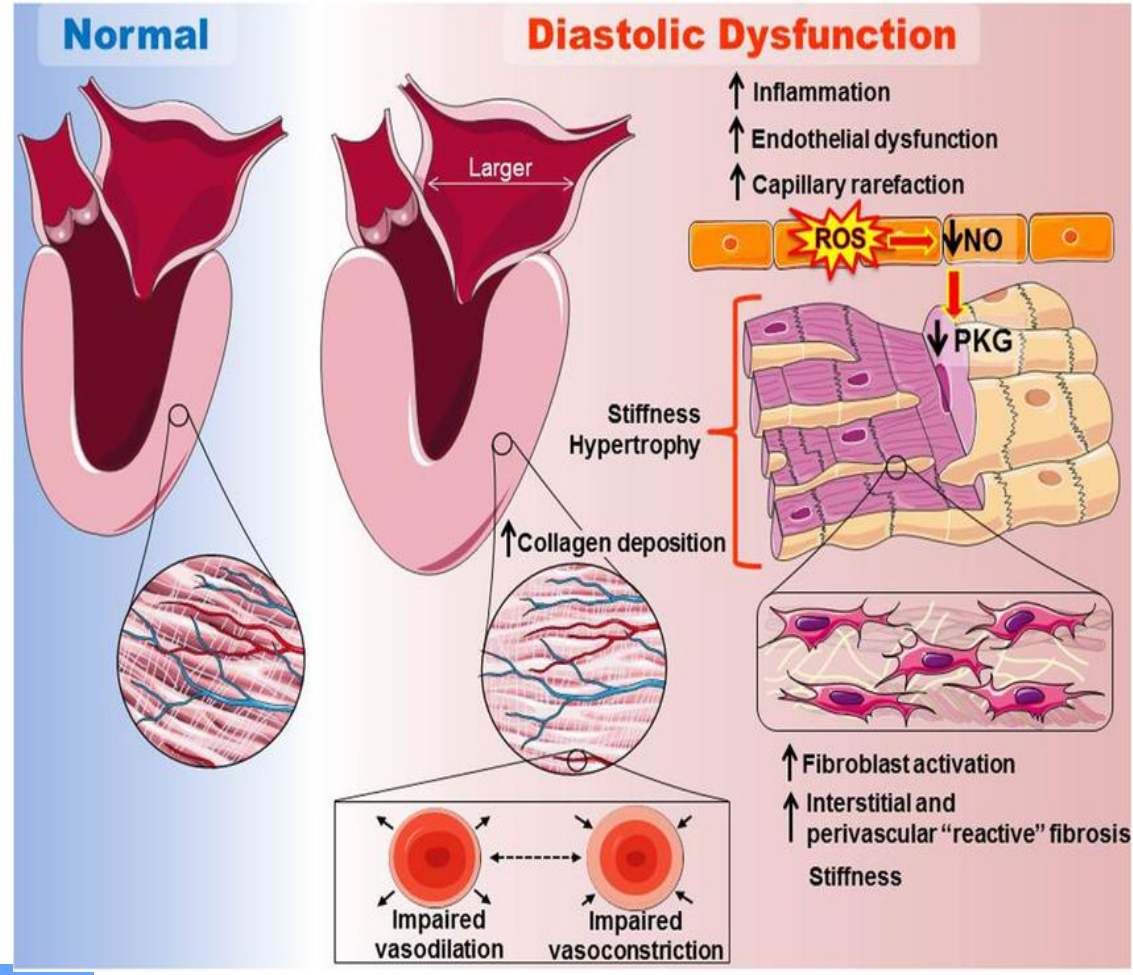


1. E/A Ratio ≥ 2
2. DT < 160 msec
3. Decreased e' velocity
4. E/e' ratio > 14
5. Increased LAP

Clinical Significance

A. Diagnostic Importance

1. Identifies **HFpEF (Heart Failure with Preserved EF)**
2. Defines **diastolic heart failure**
3. Detects early LV dysfunction (even when EF is normal)
4. Evaluates **hypertensive heart disease**
5. Assesses **LV hypertrophy and ischemia**



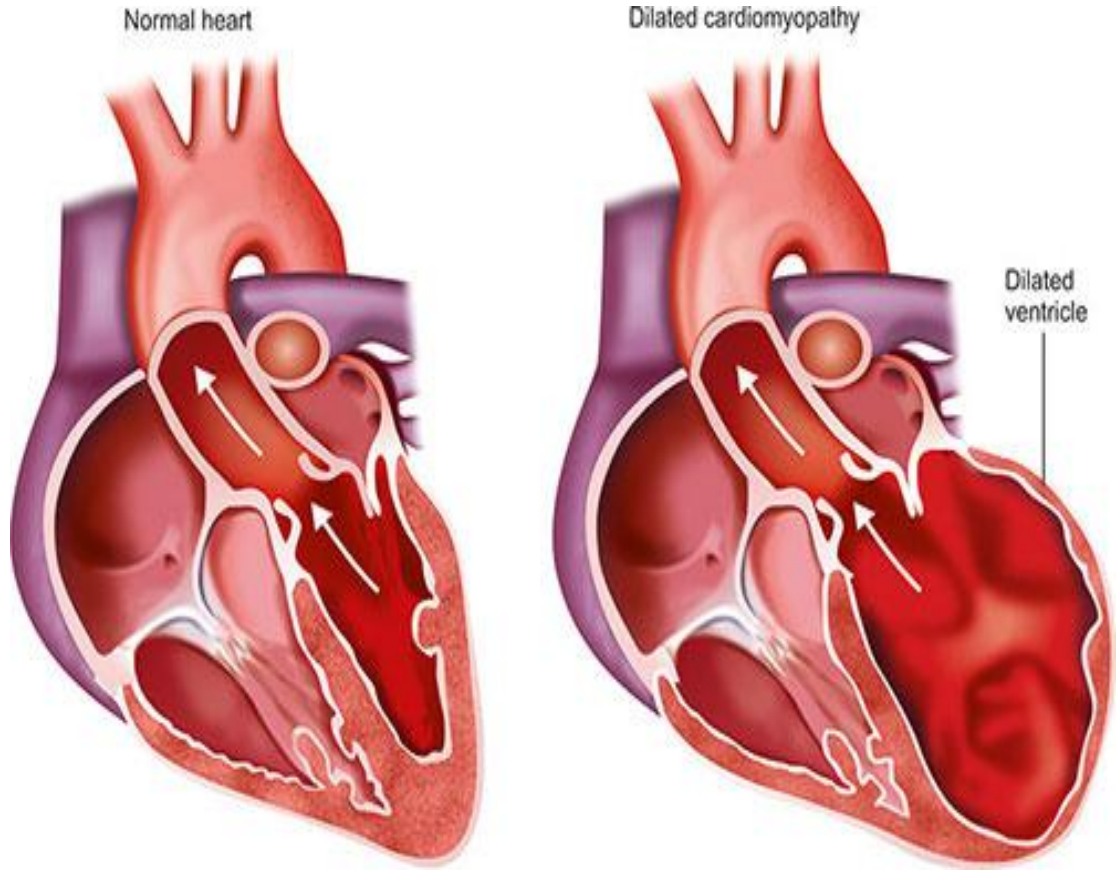
Clinical Significance

B. Prognostic Significance

Grade III has **poor prognosis**

Predicts:

1. Mortality in heart failure
2. Outcomes after MI
3. Outcomes in valvular heart disease
4. Post-surgical complications



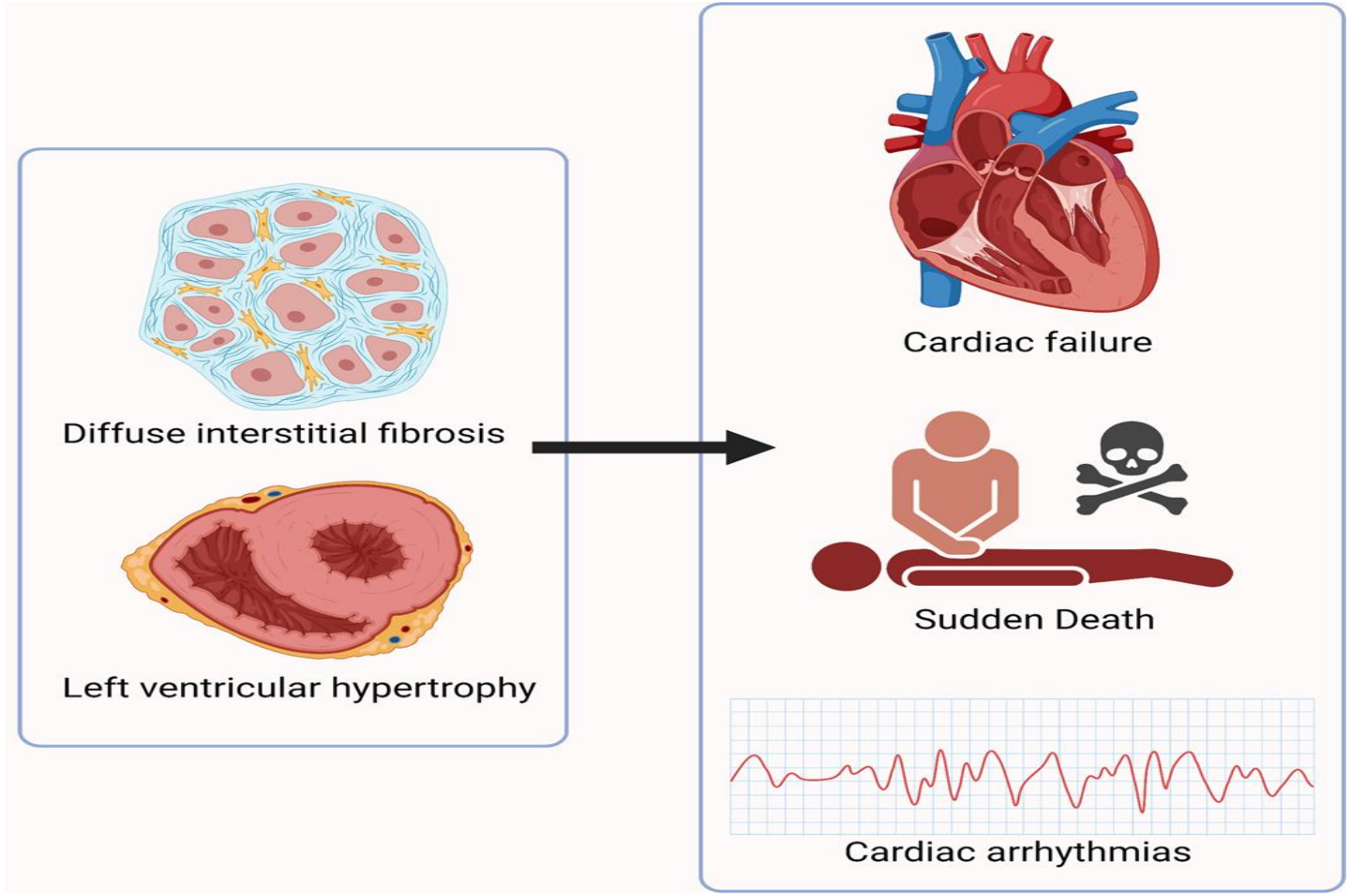
Clinical Applications

Guides **fluid therapy** in ICU

Helps determine need for diuretics

Important for:

1. Atrial fibrillation
2. Cardiomyopathies
3. Pulmonary hypertension
4. Chronic kidney disease
5. Diabetes mellitus



Summary Tables

Parameter	Normal	Abnormal	Clinical Meaning
E/A ratio	1–2	<0.8 or >2	Impaired relaxation / restrictive
DT	160–240 ms	<160 or >240 ms	Restrictive / impaired relaxation
Septal e′	>7 cm/s	<7	Reduced relaxation
Lateral e′	>10 cm/s	<10	Reduced relaxation
E/e′ ratio	<14	>14	Elevated filling pressure
LA volume index	<34 mL/m²	>34	Chronic ↑ LAP
TR Vmax	≤2.8 m/s	>2.8	↑ PAP from ↑ LAP
PV S/D ratio	>1	<1	↑ LAP
Ar–A duration	<30 ms	>30 ms	↑ LVEDP

References

1.Feigenbaum's Echocardiography **8th Edition.**

- Lippincott Williams & Wilkins; 2018.
- *Chapters: LV Diastolic Function, Doppler Hemodynamics.*

2.Textbook of Clinical Echocardiography Catherine M. Otto.

- **Textbook of Clinical Echocardiography. 6th Edition.**Elsevier; 2018.
- *Chapter on Diastolic Function and Doppler Principles.*

3. ASE/EACVI Diastolic Function Guidelines

- **Nagueh SF, Smiseth OA, Appleton CP, et al.**

  Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography.