La Funzione Diastolica

Quali parametri ecocardiografici considerare?

Cristina Porciani

Firenze

Assessment of left ventricular diastolic function is an essential component of the echocardiographic examination expecially in patients with signs and symptoms of heart failure

- Diastolic dysfunction ,even in patients with chronic heart failure that is a result of systolic dysfunction, correlates most closely with the degree of exercise limitation, independently of the severity of systolic dysfunction

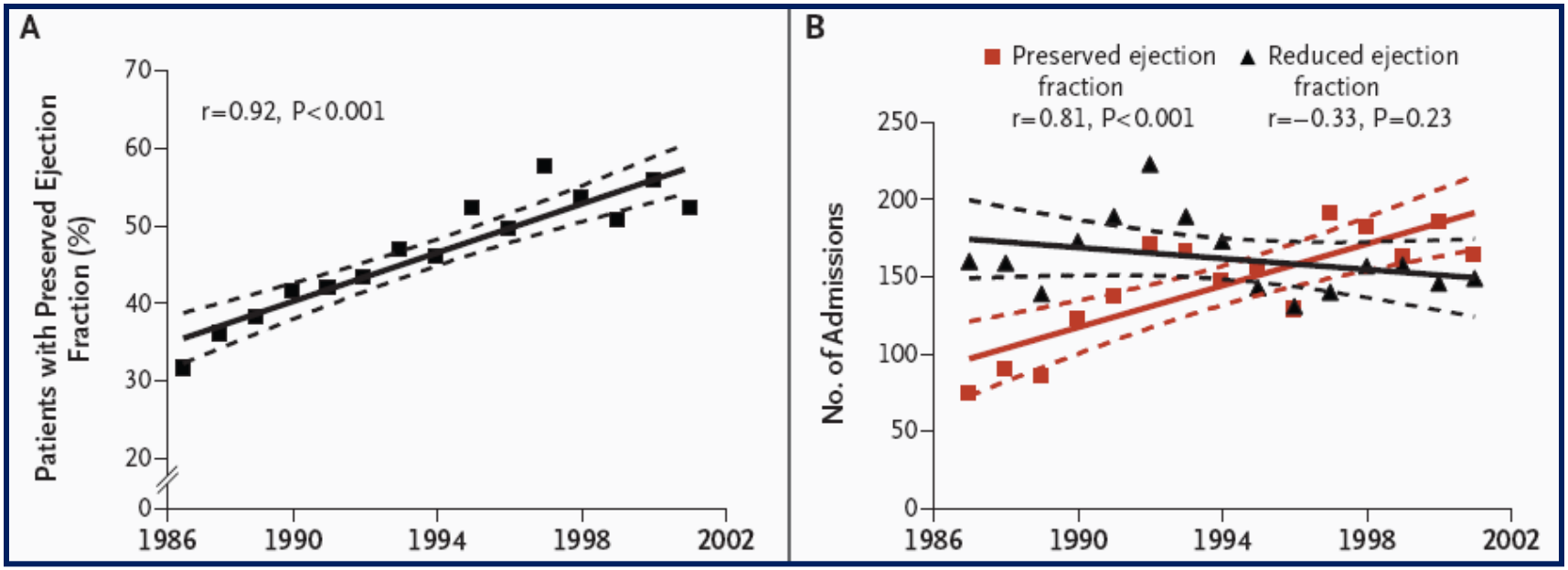
- Diastolic dysfunction with preserved LV ejection fraction is seen in almost half of patients with heart failure

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Trends in Prevalence and Outcome of Heart Failure with Preserved Ejection Fraction

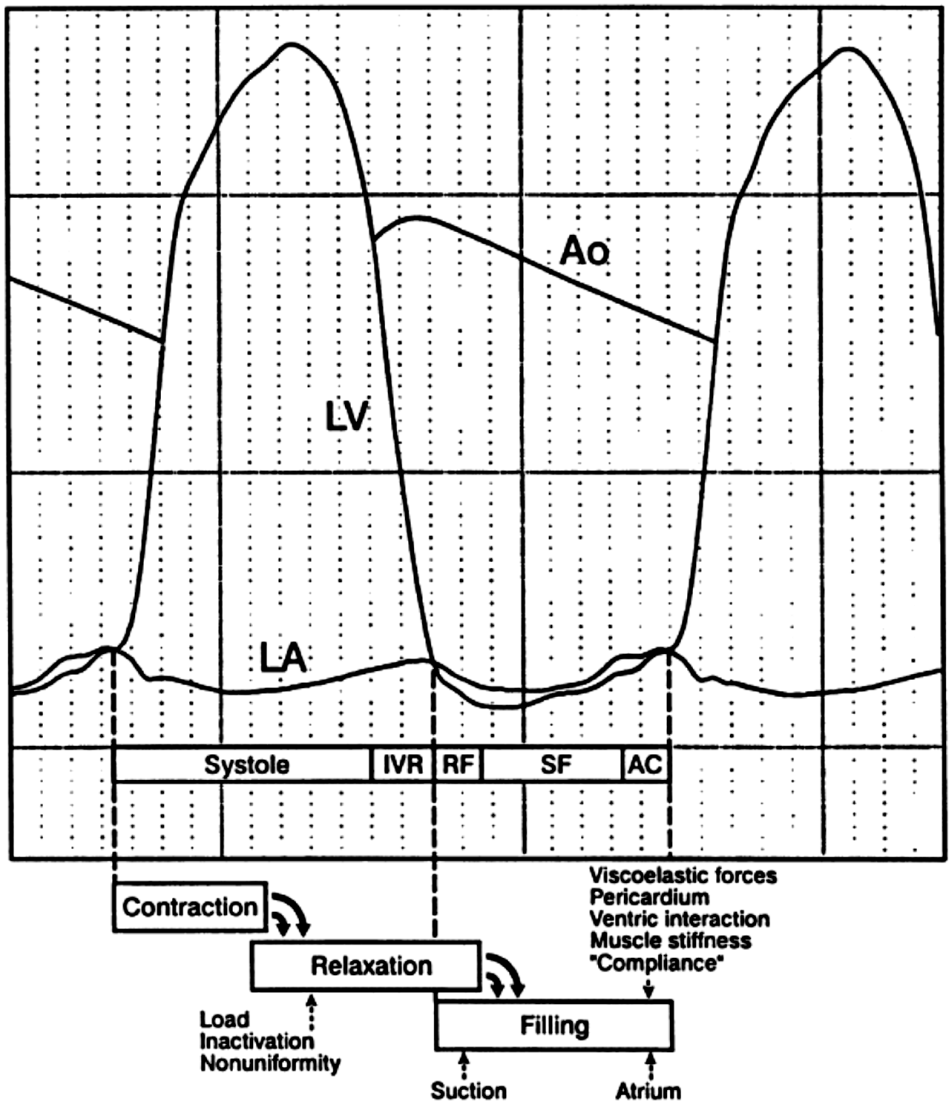
Theophilus E. Owan, M.D., David O. Hodge, M.S., Regina M. Herges, B.S., Steven J. Jacobsen, M.D., Ph.D., Veronique L. Roger, M.D., M.P.H., and Margaret M. Redfield, M.D.

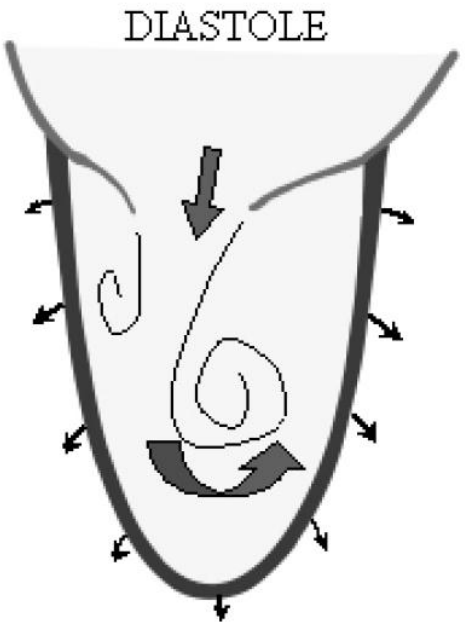


Secular Trends in the Prevalence of Heart Failure with Preserved Ejection Fraction.

NEJM 2006

Physiology


Ao
LV
LA
Systole
IVR
RF
SF
AC
Contraction
Relaxation
Filling
Viscoelastic forces
Pericardium
Ventric interaction
Muscle stiffness
"Compliance"
Load
Inactivation
Nonuniformity
Suction
Atrium

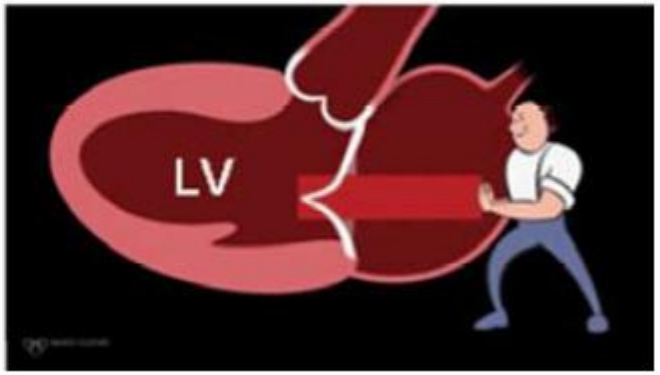


LV filling is primarily dependent on

* Myocardial relaxation
* Ventricular compliance

Abnormalities of either can alter LV filling and lead to elevated filling pressures

Normal disastolic function



Diastolic dysfunction

Elevated filling presures represent the physiologic consequence of diastolic dysfunction

(PCWP) > 12 mm Hg
LVEDP >16 mm Hg

Cardiac Catheterization is the standard technique for direct measurement of filling pressures

.

Transmitral Blood Flow Reflecting Diastolic Behavior of the Left Ventricle in Health and Disease
–A Study by Pulsed Doppler Technique–

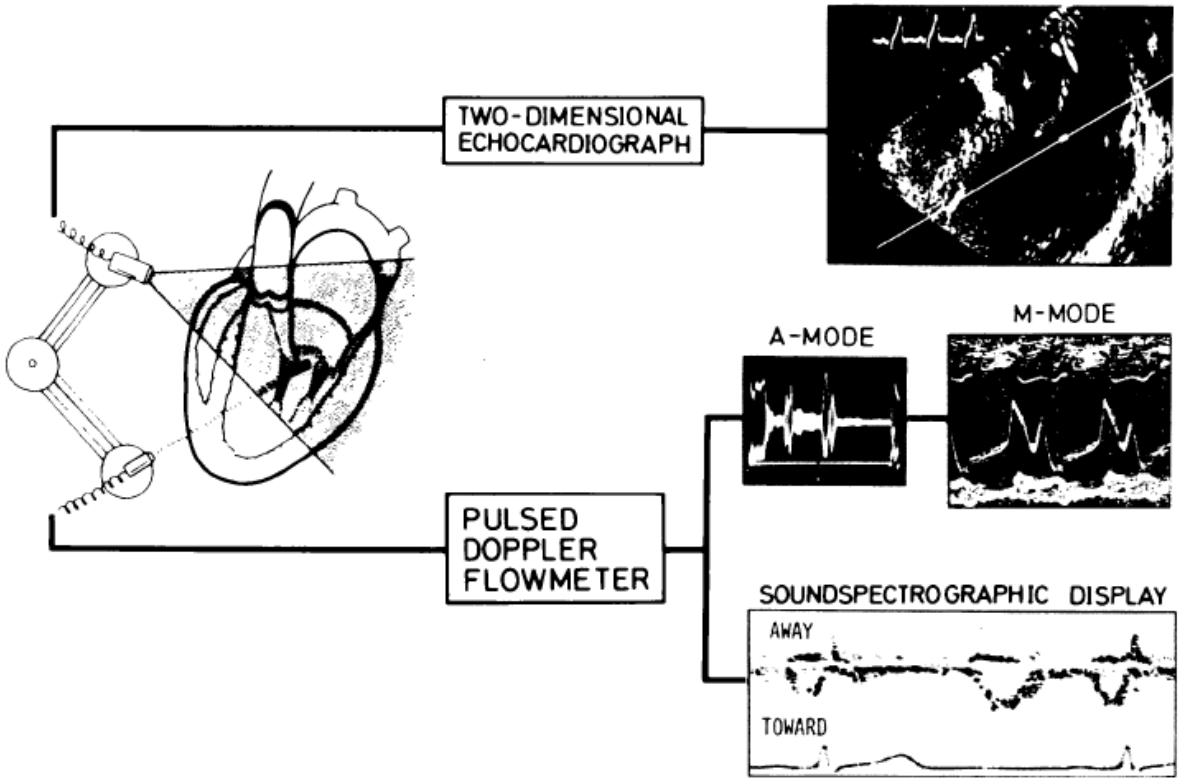


Fig.1. Schematic drawing of the ultrasonic combined system. An illustration of the combined system is shown in the left panel. In the two-dimensional echocardiogram (*upper right*), the Doppler beam direction is displayed as a white line and a rectangular white mark indicates the sample site along the beam. The Doppler signal obtained by the flowmeter is displayed by a soundspectrograph (*lower right*).

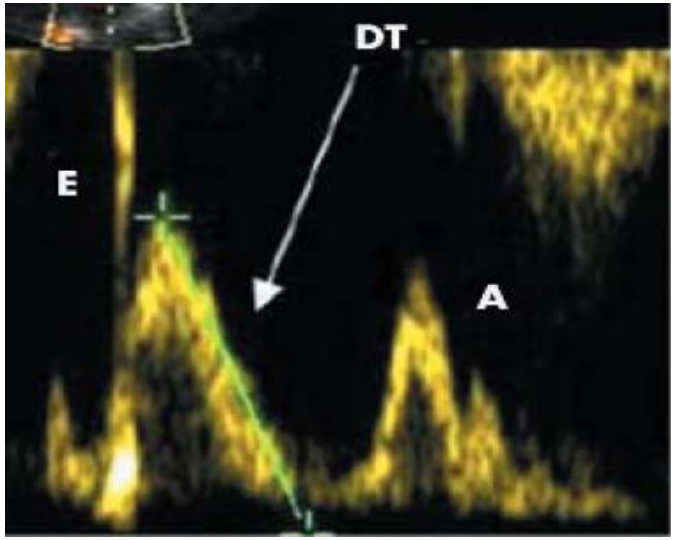
JACC Vol. 30, No. 1
July 1997:8–18

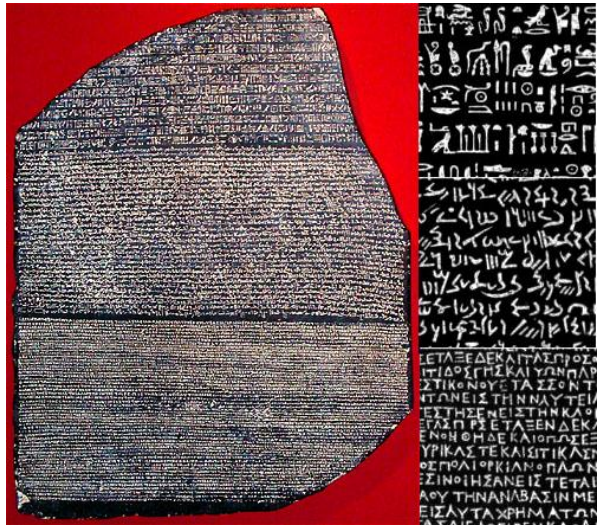
REVIEW ARTICLE

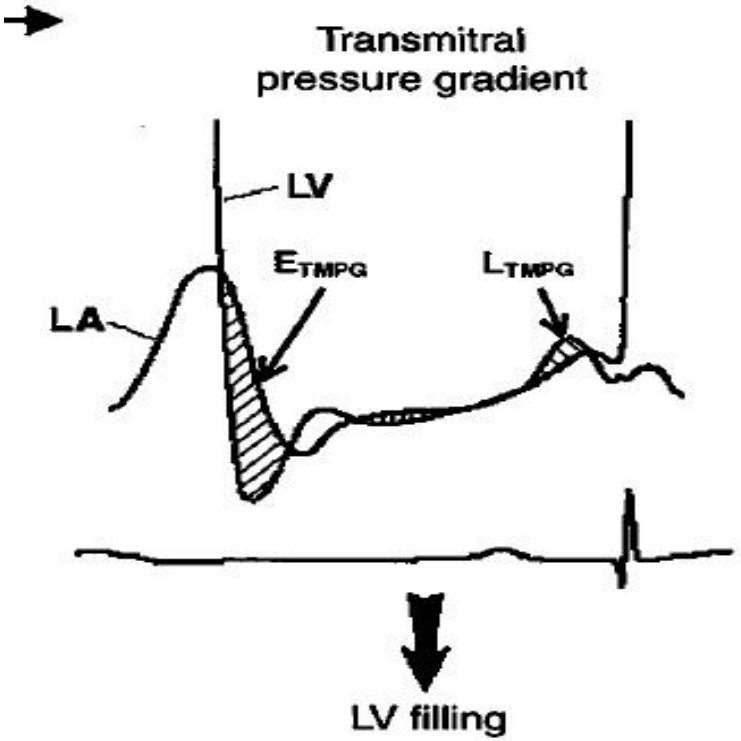
Evaluation of Diastolic Filling of Left Ventricle in Health and Disease: Doppler Echocardiography Is the Clinician's Rosetta Stone

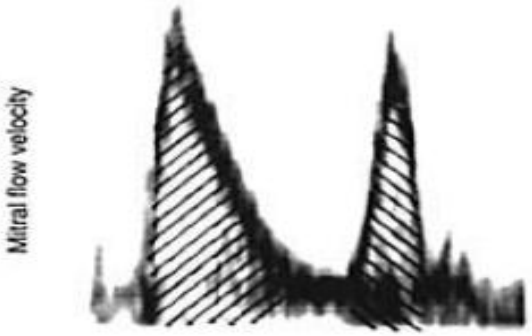
RICK A. NISHIMURA, MD, FACC, A. JAMIL TAJIK, MD, FACC

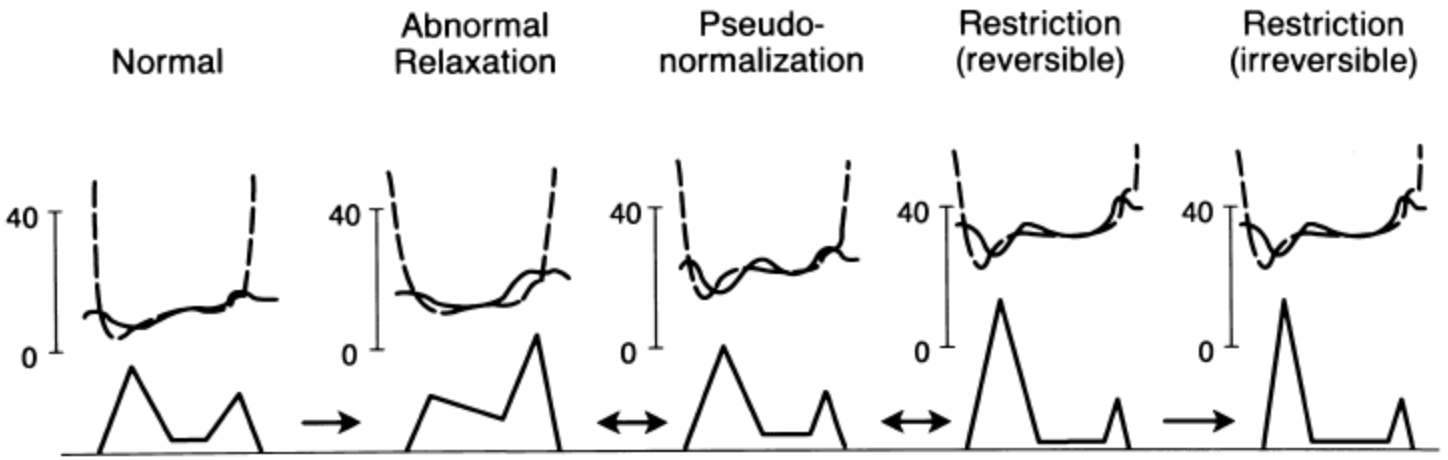
Rochester, Minnesota



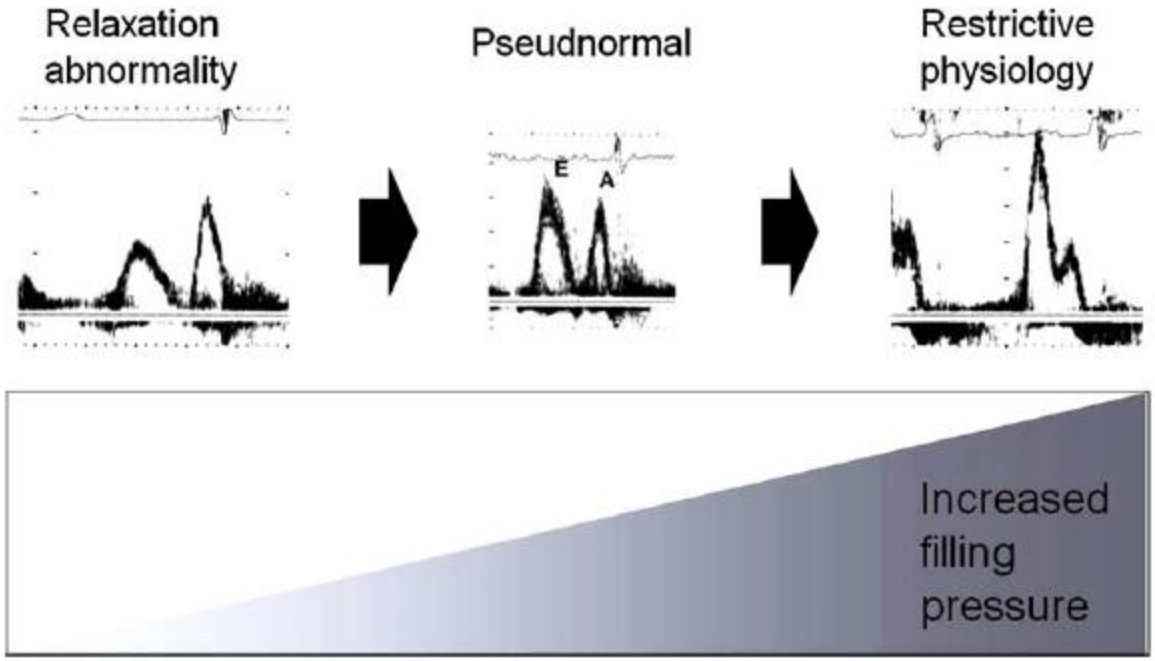


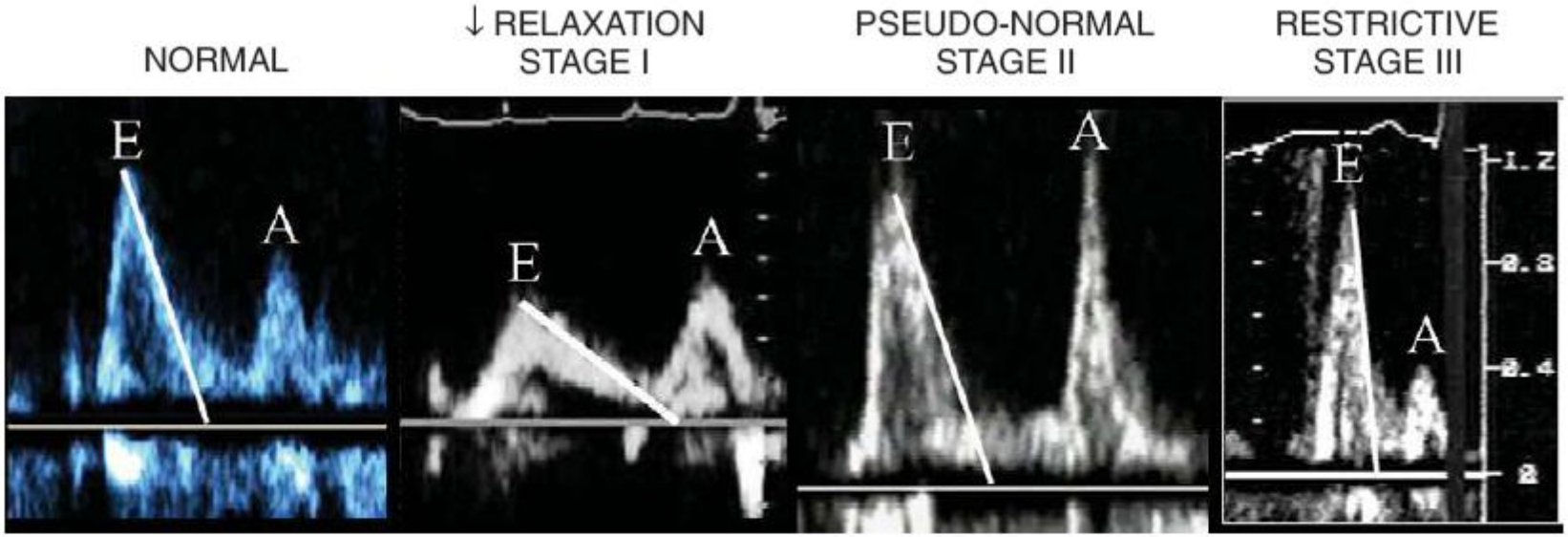

Transmitral
pressure gradient
LV
E_{TMPG}
L_{TMPG}
LA
LV filling


Mitral flow velocity

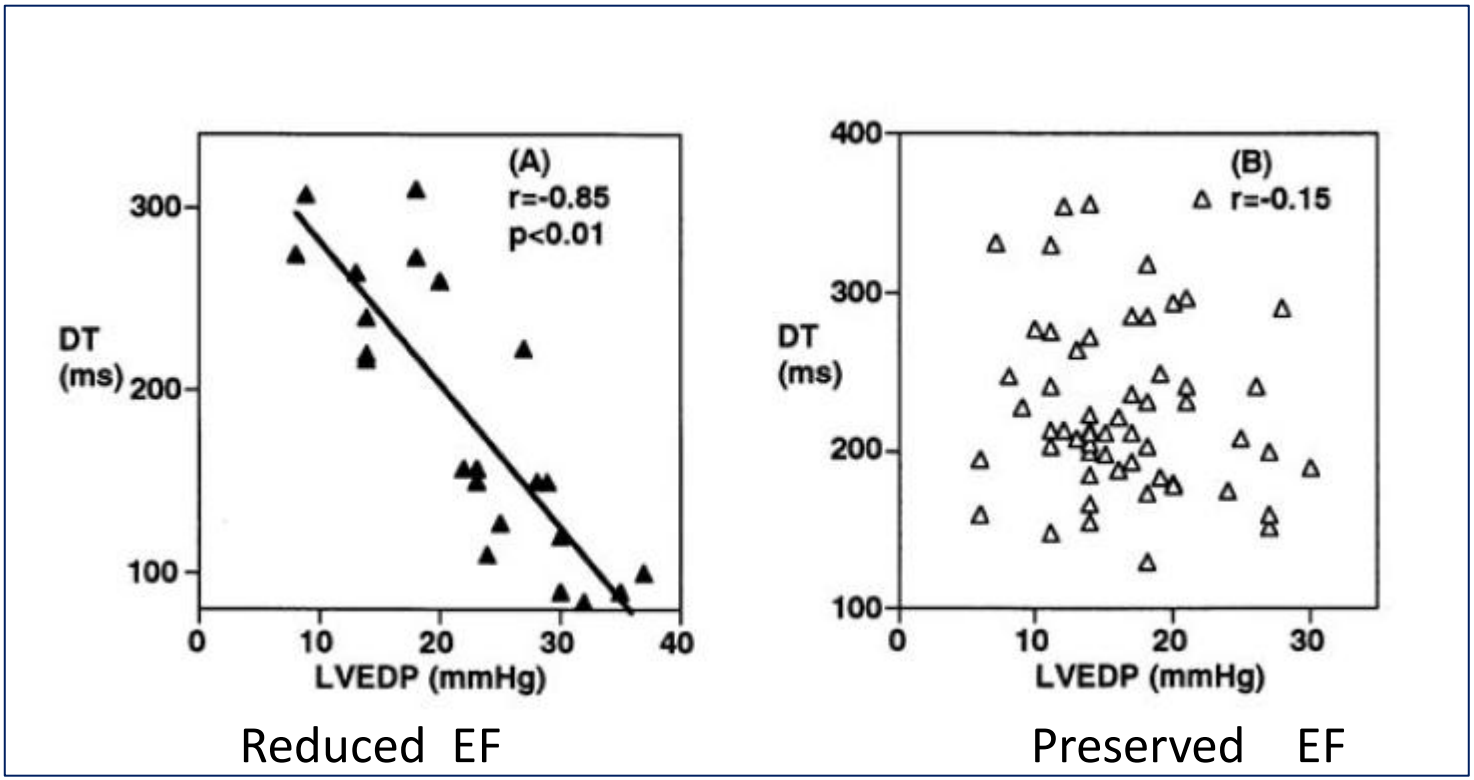


Mean LAP	=	= ↑	↑↑	↑↑↑	↑↑↑
TAU	=	↑	↑	↑↑	↑↑
NYHA		I-II	II-III	III-IV	IV
Grade diastolic dysfunction		**I**	**II**	**III**	**IV**


Relaxation abnormality
Pseudnormal
Restrictive physiology
E
A
Increased filling pressure



NORMAL	↓ RELAXATION STAGE I	PSEUDO-NORMAL STAGE II	RESTRICTIVE STAGE III
E/A >1	E/A <1	E/A 1–2	E/A >2
DT 150–240	DT >240	DT 150–240	DT <150
IVRT <90 msec	IVRT >90 msec	IVRT <90 msec	IVRT <70 msec

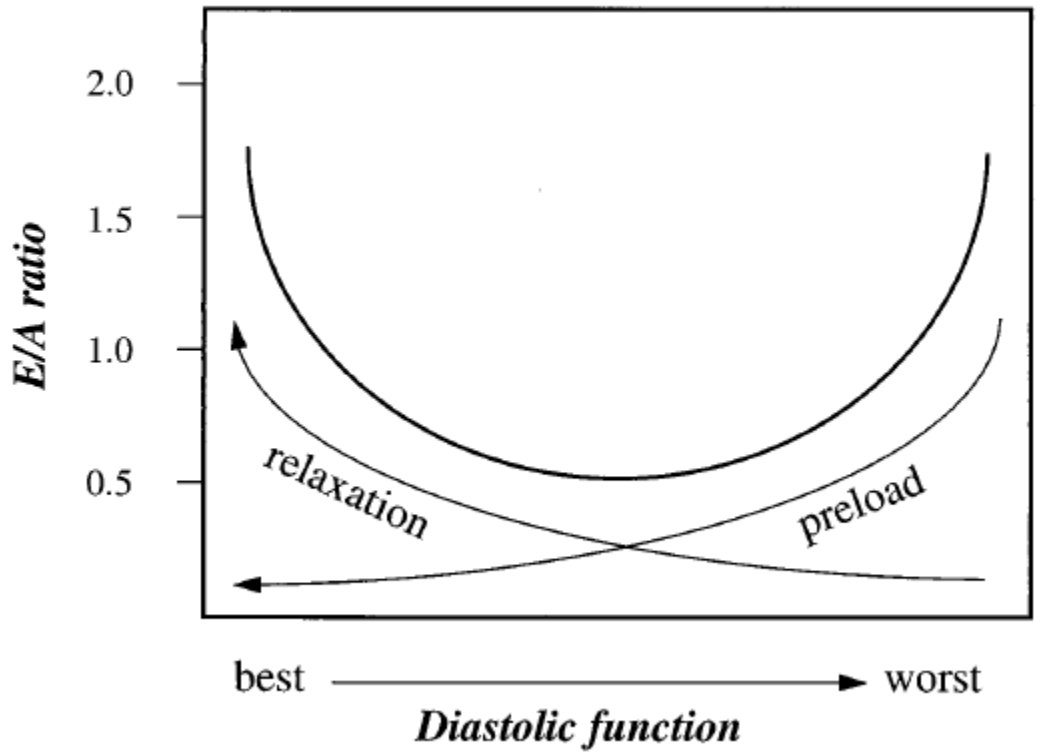


Reduced EF

Preserved EF

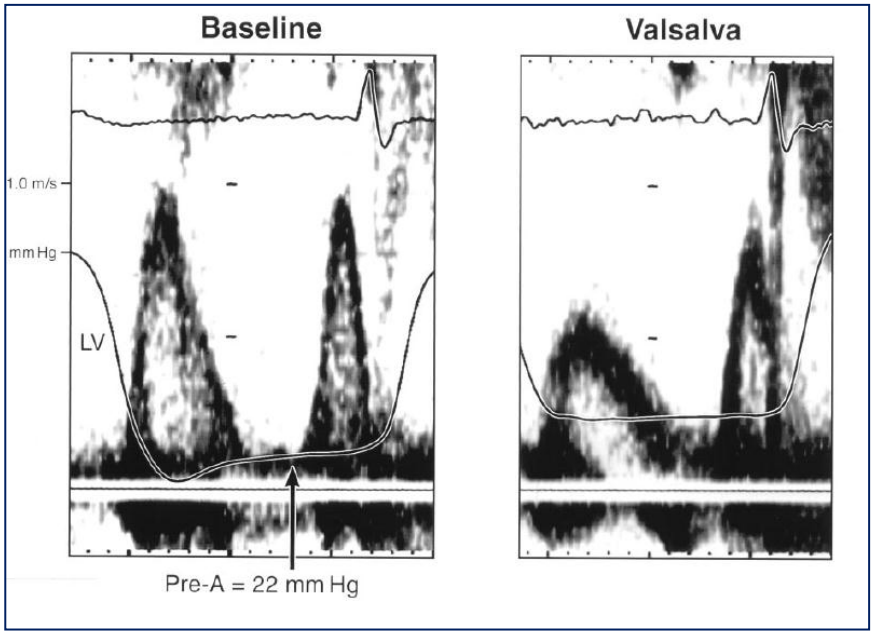
Mitral pattern does not predic diastolic dysfunction in pts with preserved EF

Yamamoto K JACC 1819



Garcia MJ JACC 1998

Manovra di Valsalva

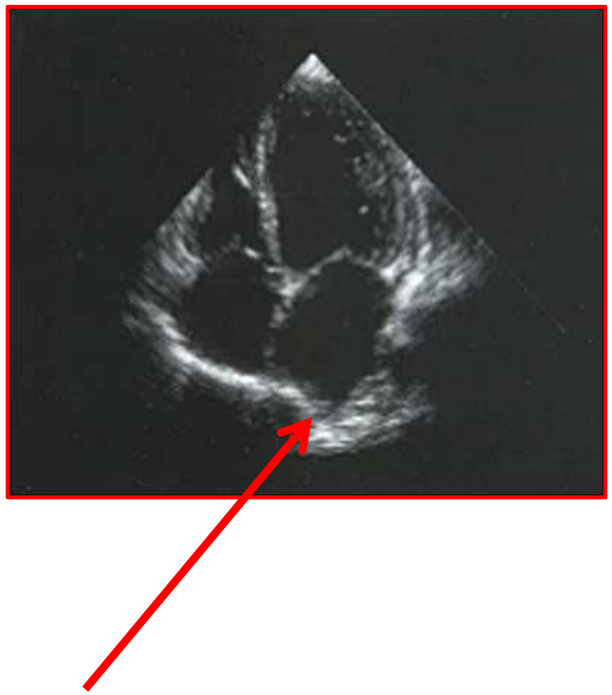


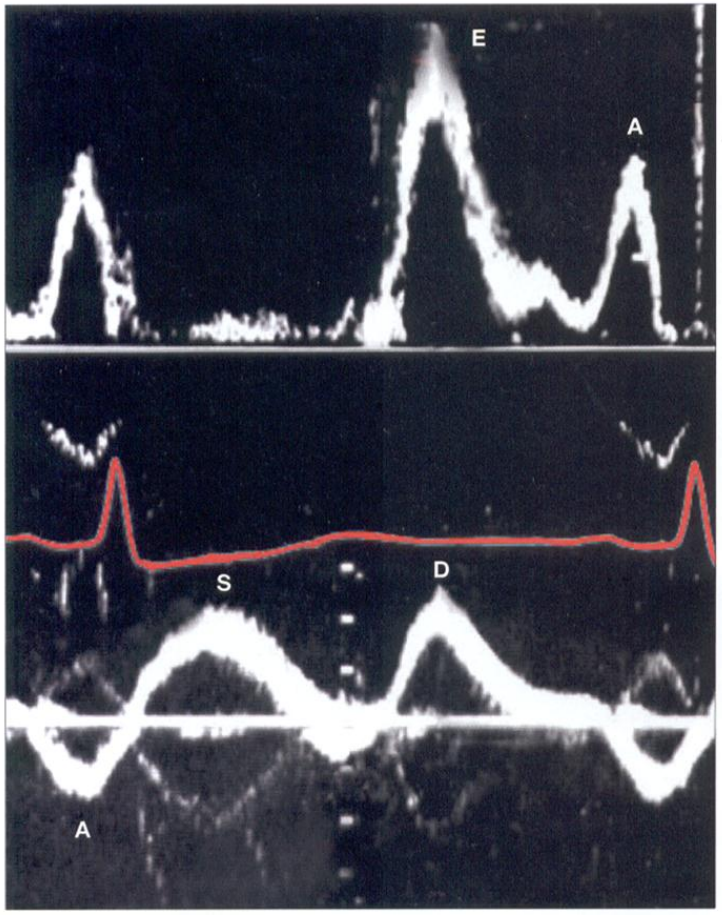
Proposed criteria for identifyng pseudonormalization

Decrease ≥ 50% in the E/A ratio

Increase in A velocity

Pulmonary Venous Flow

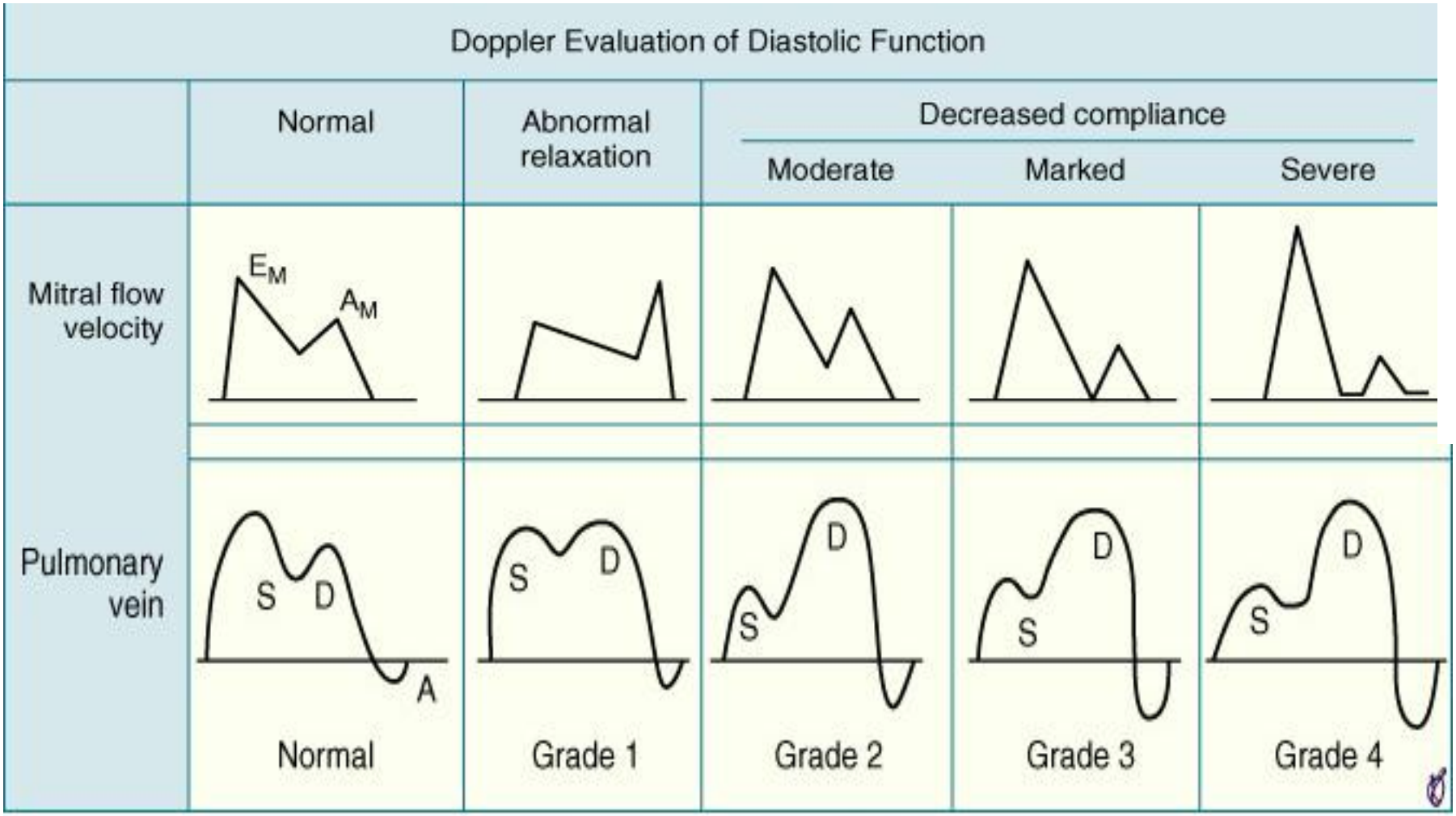


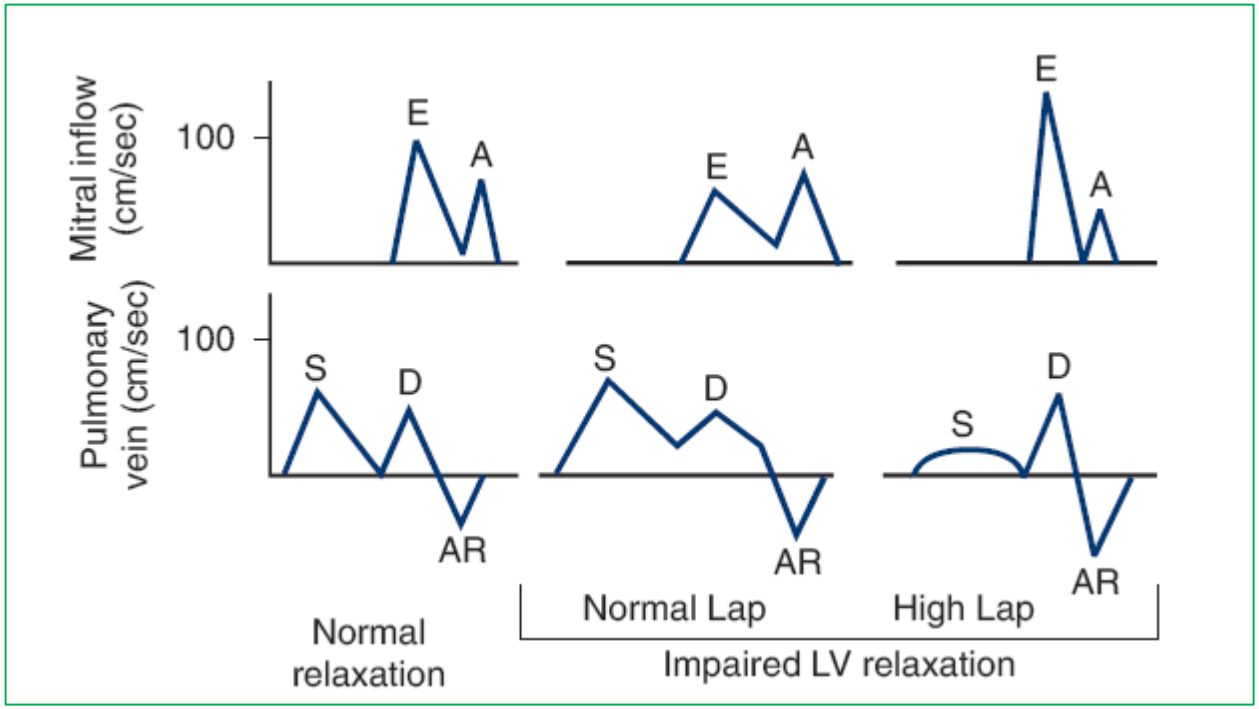


Afflusso mitralico del LV

Flusso delle vene polmonari

Pulmonary venous flow





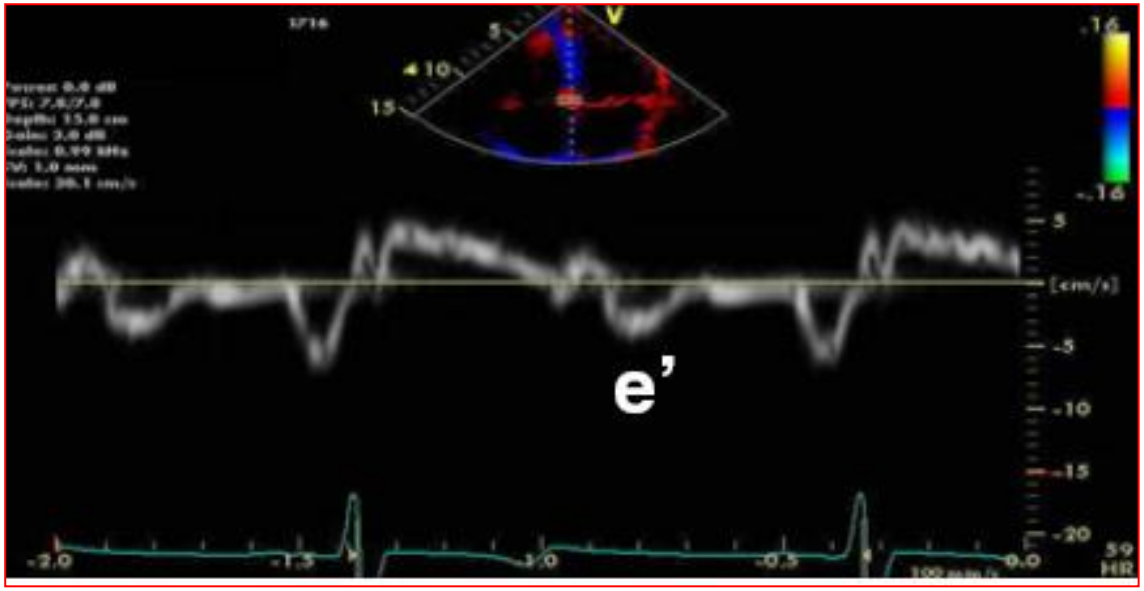
Diastolic dysfunction

- S/D < 1
- AR peak > 35cm/sec
- Ar duration - mitral A wave duration > 30ms *

* Predictive also in patients with HFNEF

E’

Tissue Doppler Mitral Annulus Velocities



- The e1 velocity is less a less preload dependent measure of myocardial relaxation than transmitral E wave

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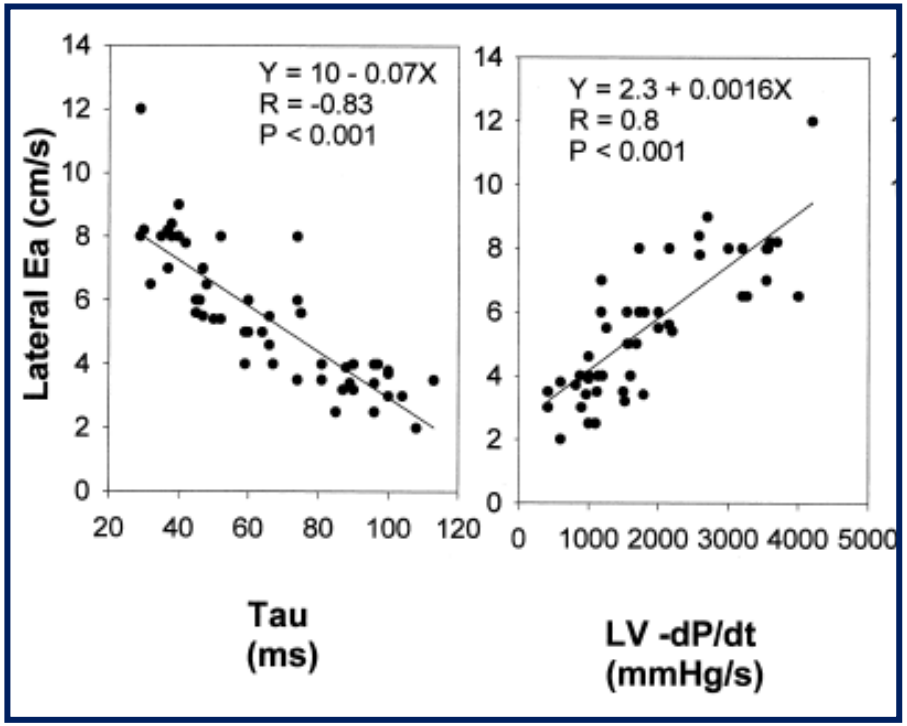
PII S0735-1097(00)01056-1

Hemodynamic Determinants of the Mitral Annulus Diastolic Velocities by Tissue Doppler

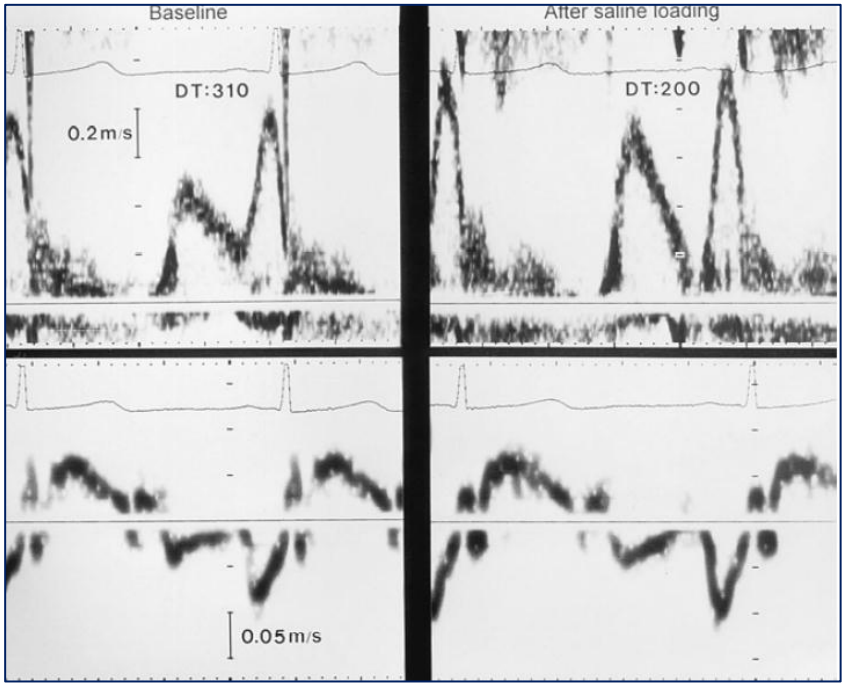
Sherif F. Nagueh, MD, FACC, Huabin Sun, MD, Helen A. Kopelen, RDMS, Katherine J. Middleton, RCT, Dirar S. Khoury, PHD



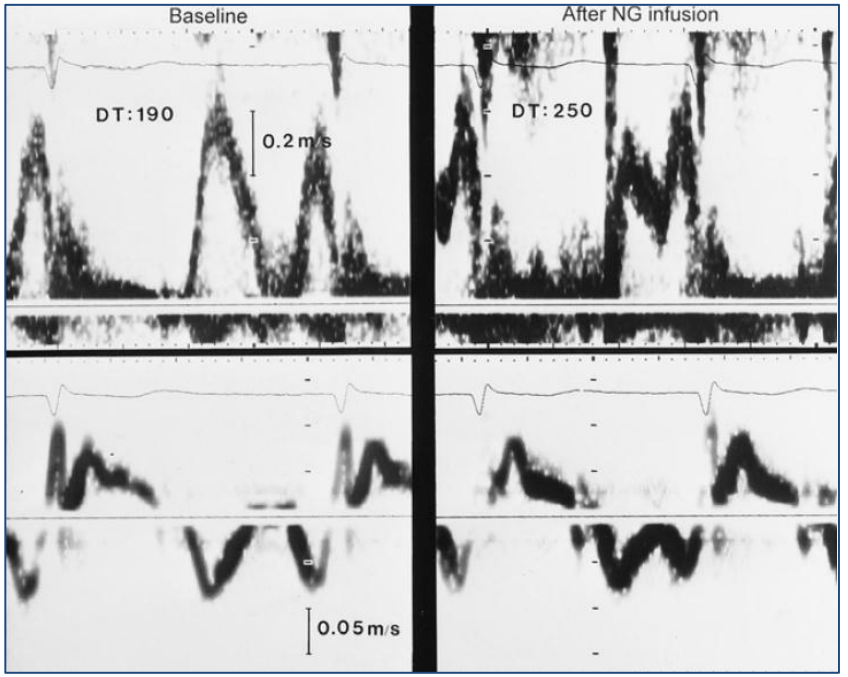
Relation of lateral annular Ea to tau and to LV -dP/dt

E’

E’ velocity is less a less preload dependent measure of myocardial relaxation than transmitral E wave



Before and after saline loading

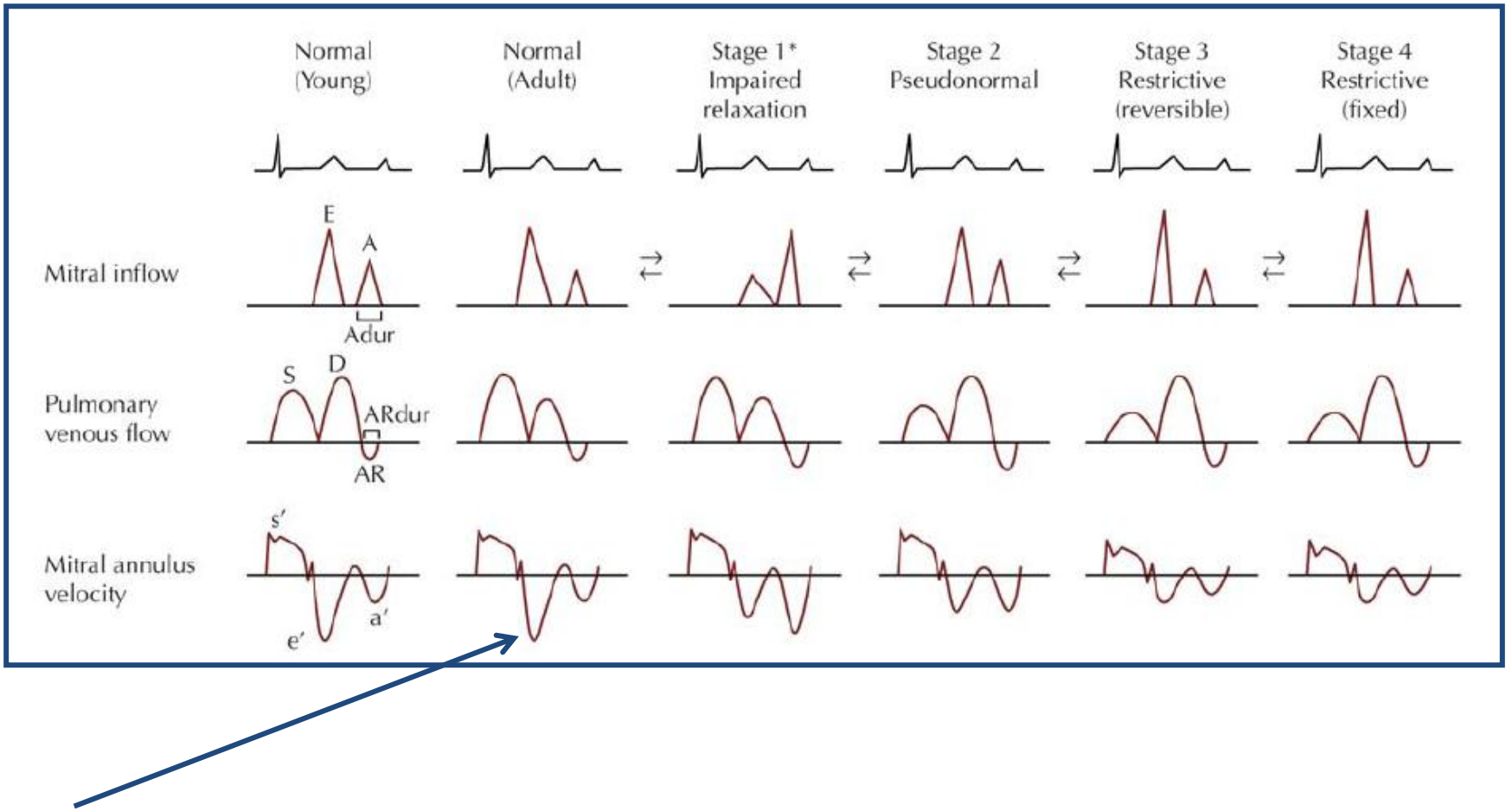


Before and after nitroglycerin infusion

Sohn DW JACC 2007

E’

E’ velocity falls with progressive diastolic dysfunction



E’

E’ may be a subclinical marker of cardiac disease

Demographic, Two-Dimensional, and Doppler Echocardiographic Parameters

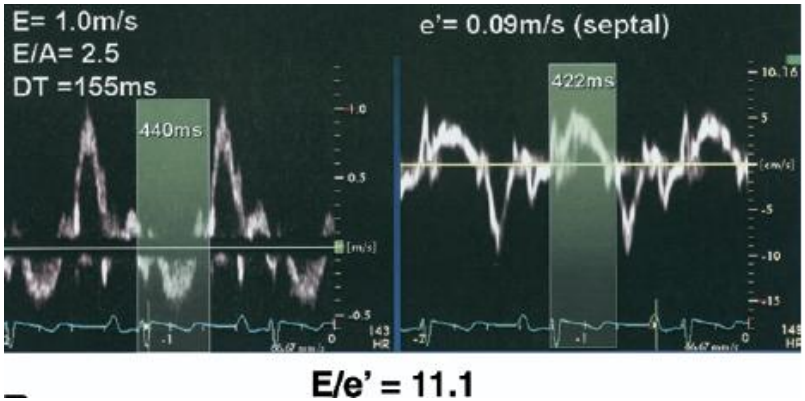
	Control Group	NCA Group	CA Group	P <
Age	65.7 ± 8.5	71.2 ± 9.8	66.9 ± 10.9	NS
LAD (mm)	37.3 ± 3.7	39.7 ± 5.6	44.6 ± 6.3*	0.0001
LAA_{ind} (cm^2/m^2)	8.9 ± 1.6	11.1 ± 1.8#	13.4 ± 2.1&	0.0001
$LVDD_{ind}$ (mm/m^2)	25.4 ± 2.5	26.2 ± 3.1	24.8 ± 3.3	NS
$LVSD_{ind}$ (mm/m^2)	15.7 ± 2.4	15.5 ± 2.9	16.2 ± 4.3	NS
FS (%)	38.4 ± 6.6	41 ± 7	35.3 ± 12	NS
IVS (mm)	9.9 ± 1.1	10.5 ± 0.9	15.8 ± 2.6&	0.0001
PW (mm)	9.9 ± 0.8	10.3 ± 0.9	15.9 ± 2.3&	0.0001
LV $mass_{ind}$ (g/m^2)	89.2 ± 21.8	96.3 ± 22	162.9 ± 36.2&	0.0001
RVDD (mm)	26.5 ± 4.1	25.4 ± 5.9	27.4 ± 5.5	NS
RVFW (mm)	5.3 ± 1	6.6 ± 1.2£	7.4 ± 1.2	0.01
LVEDV (mL)	92.5 ± 27.5	78.4 ± 21.7	75.7 ± 24.3**	0.05
LVESV (mL)	34.9 ± 12	32.4 ± 13.7	33.5 ± 17.7	NS
EF (%)	62.3 ± 5.5	59.2 ± 10.5	57.1 ± 11.1	NS
E (cm/sec)	61.6 ± 11	77.1 ± 15.6#	80.4 ± 17.7*	0.0001
A (cm/sec)	67.5 ± 18.1	89 ± 17.9#	58.4 ± 28.1*	0.0001
E/A	0.95 ± 0.23	0.89 ± 0.2	1.72 ± 09&	0.0001
E′ (cm/sec)	9.1 ± 2.2	7.6 ± 2.1£	4.6 ± 1.1&	0.0001
E/E′	7.2 ± 2.4	10.8 ± 3.9$	18.2 ± 5.7&	0.0001
MPISX	0.4 ± 0.1	0.34 ± 0.1	0.55 ± 0.26***	0.0001
TAPSE (mm)	23.5 ± 4	22.1 ± 3.8	17.5 ± 4.6*§	0.0001

no cardiac amyloidosis cardiac amyloidosis

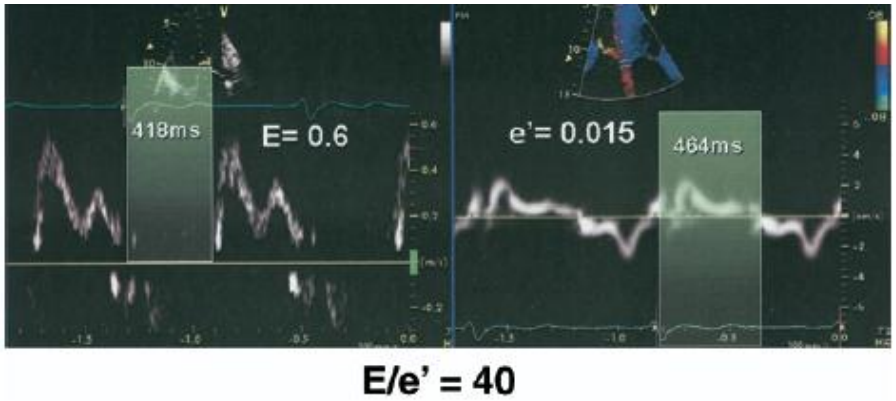
Porciani et al Echocardiography 2010

$T_{E-e'}$

Increased time interval between E and E' onset predicts elevated filling pressure



E/e' = 11.1

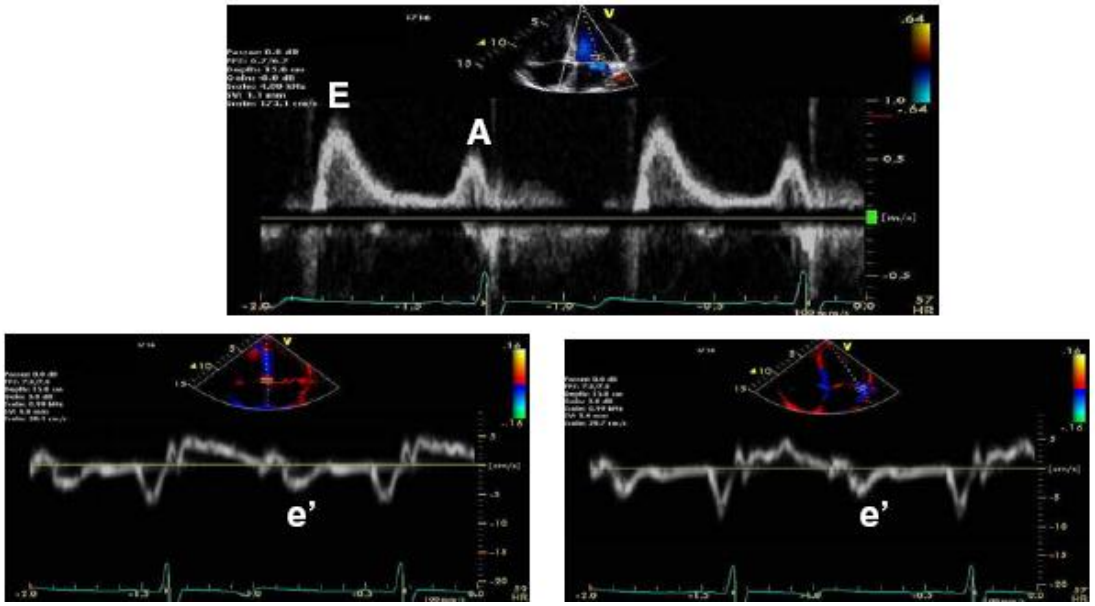


E/e' = 40

- $T_{E-e'}$ > 29ms
- IVRT/ $T_{E-e'}$ >2

E/e’

Mitral Inflow and Annulus TD



With E/e’ ratio , e’ velocity for the myocardial relaxation contribution to mitral E velelocity allowing an estimate of LV filling pressure

E/e’

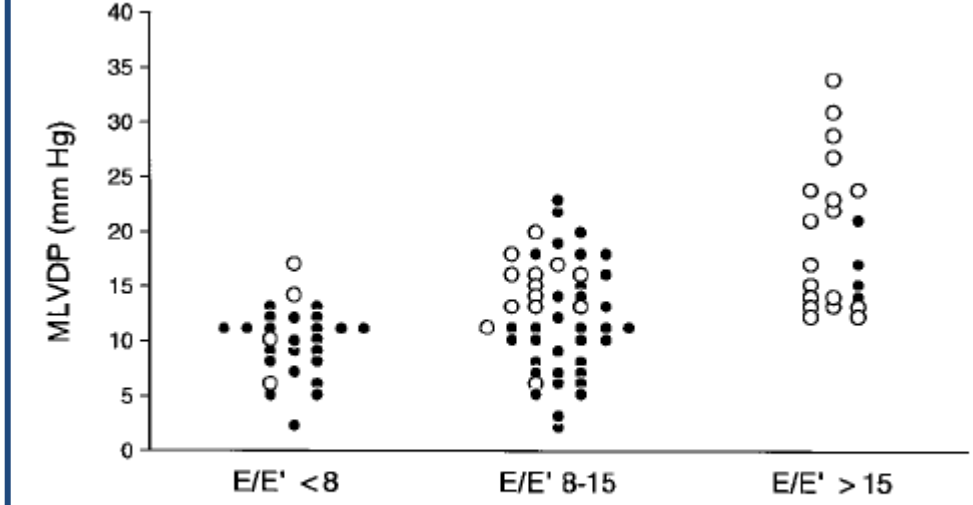


Figure 6. M-LVDP versus groups defined by values of septal E/E′. ○ Indicates patients with EF <50%; ●, patients with EF >50%.

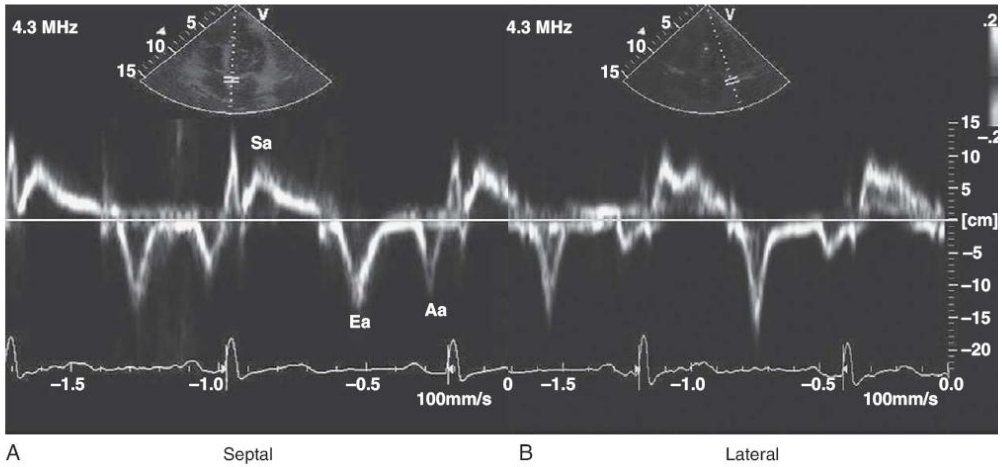
E/E’ < 8 normal filling pressure

E/E’ > 15 elevated filling pressure

Omen SR et al Circulation 2000

E/e’

Septal e’ velocity is lower than the lateral e’ velocity



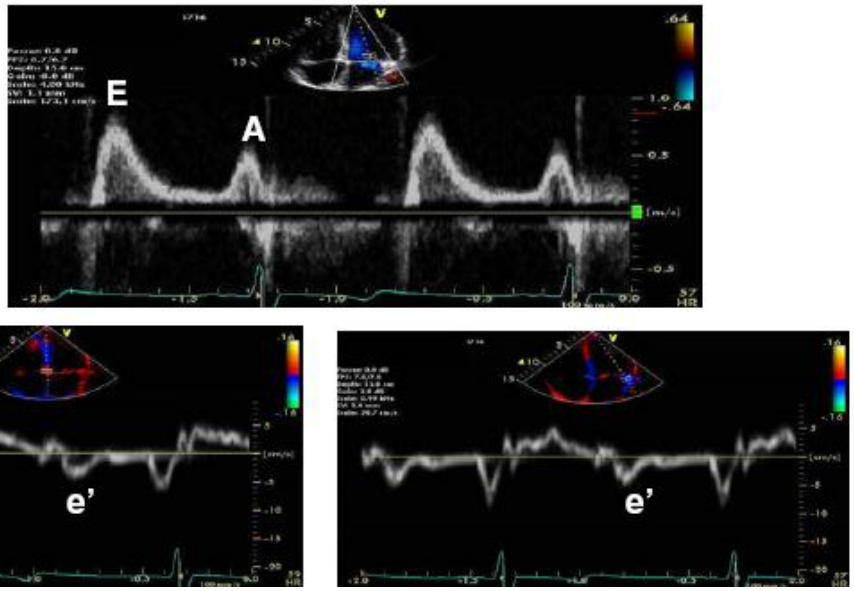
Different cut-off for predicing elevated filling pressures

Septal e’ ≥ 15.

Lateral annulus: E/e’ ratio ≥ 12

Average of the septal and lateral annular E/e’ ratio ≥ 13

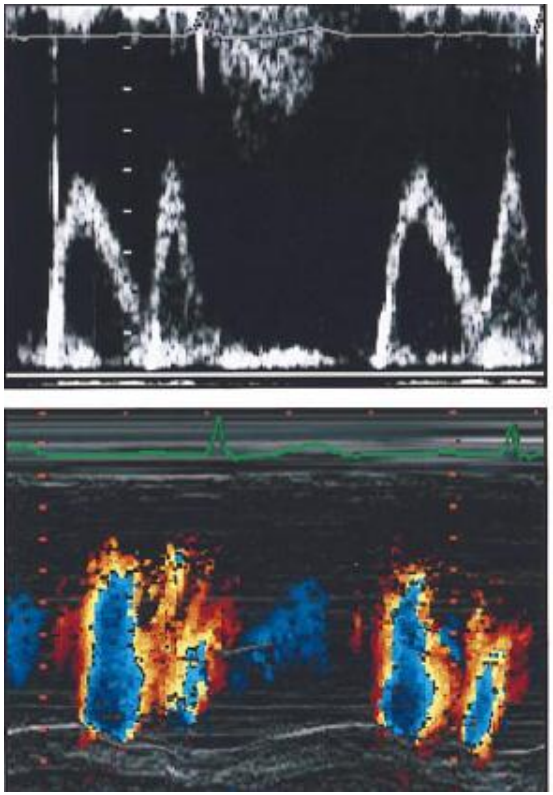
E/e’



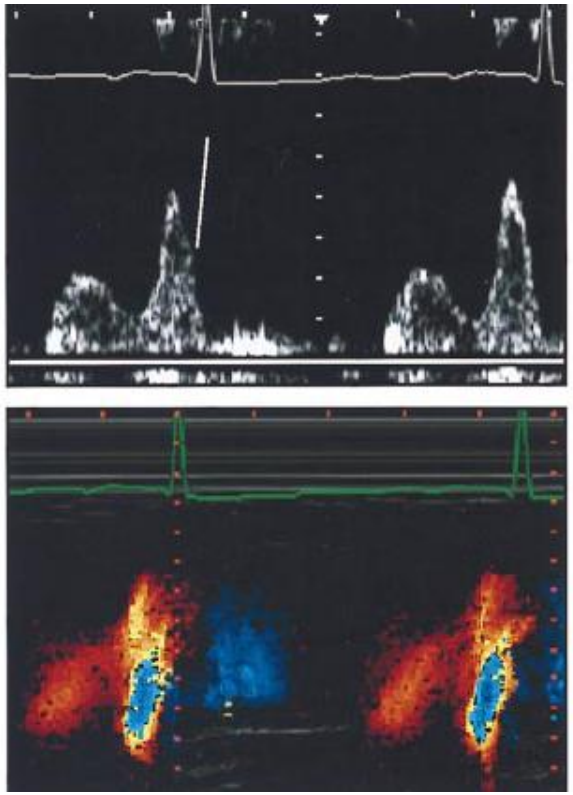
- *E/e’ ratio has the best correlation with LV filling pressure in pts with normal EF*

- *Recent data suggest that the correlation between E/e’ and LV filling pressures may be modest in hypertrophic cardiomyopathy and in pts with severe systolic dysfunction*

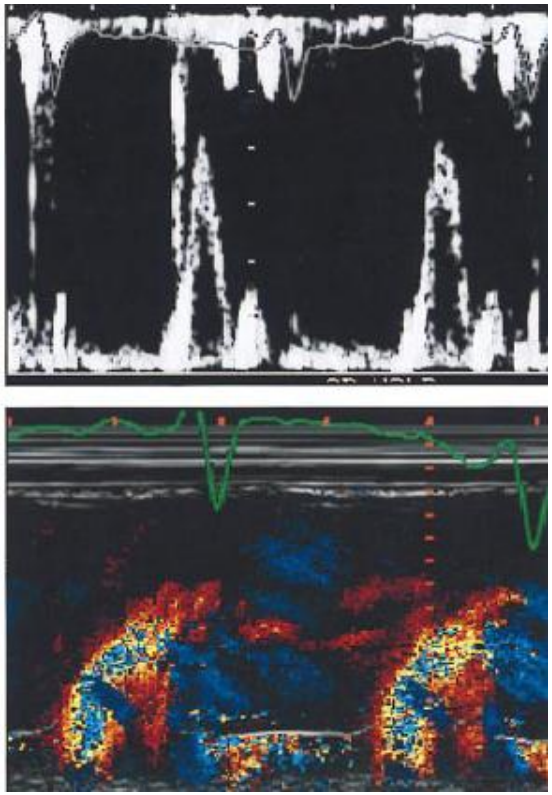
Mitral inflow propagation velocity (Vp).



Normal

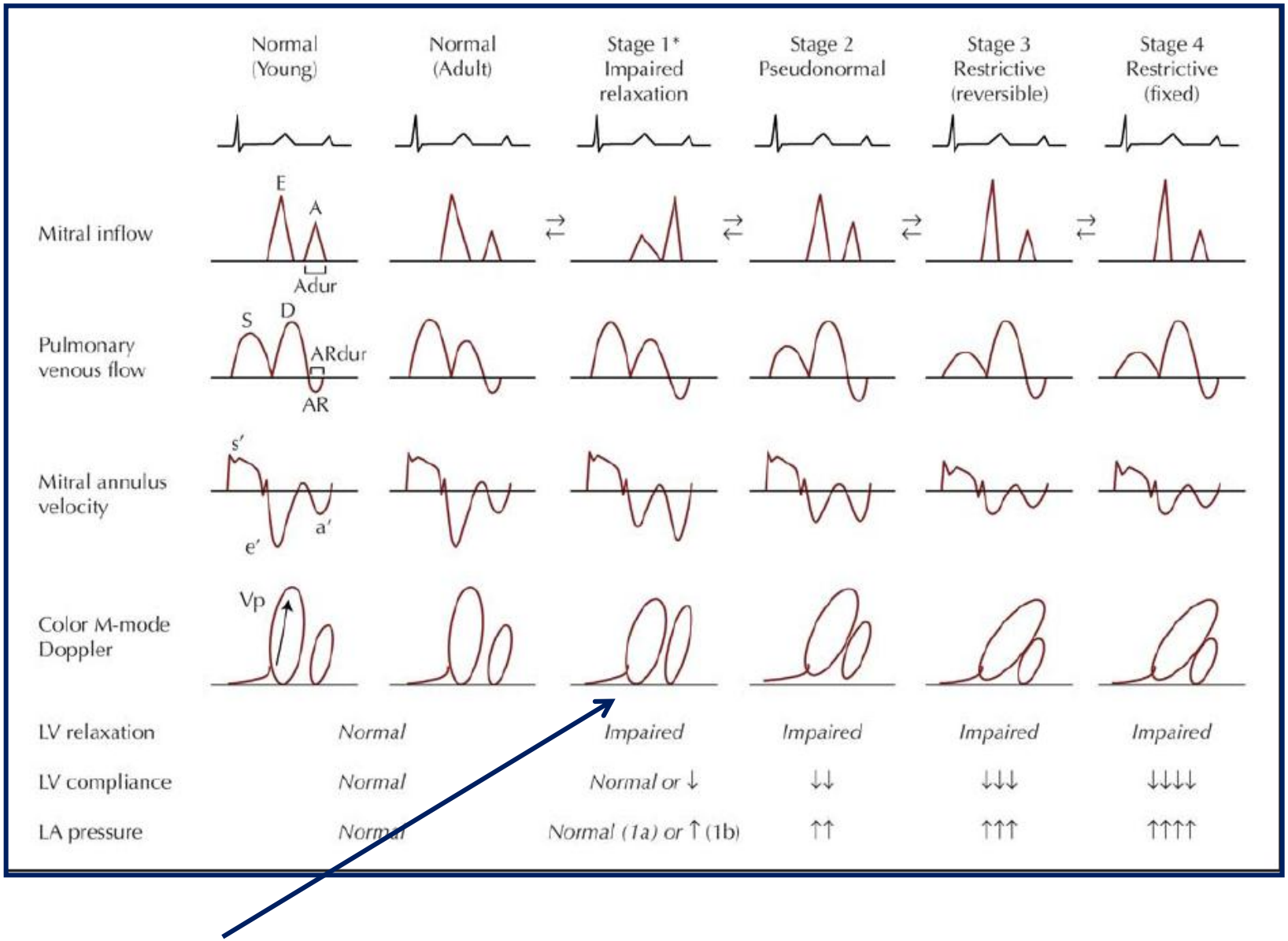


Delayed relaxation

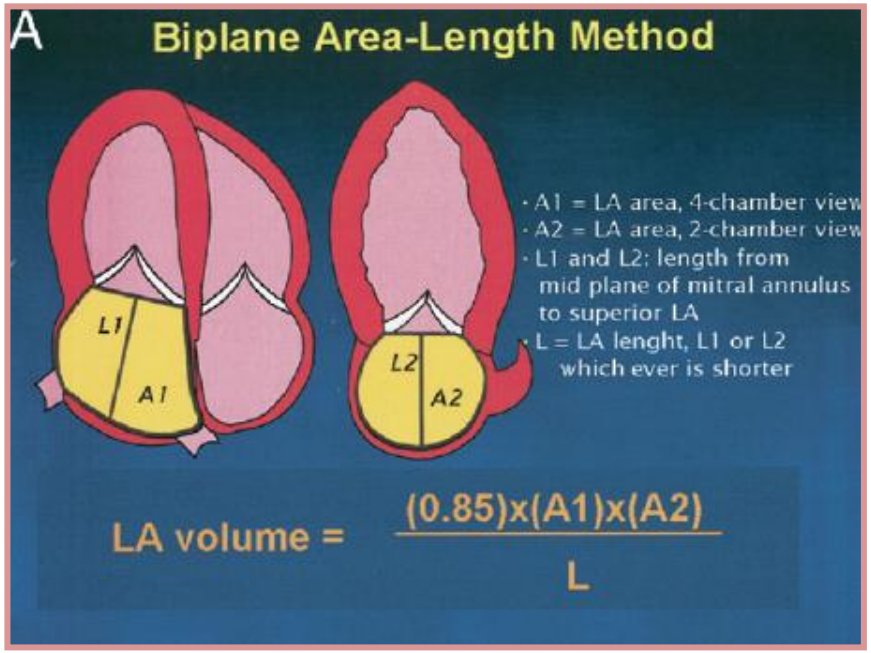


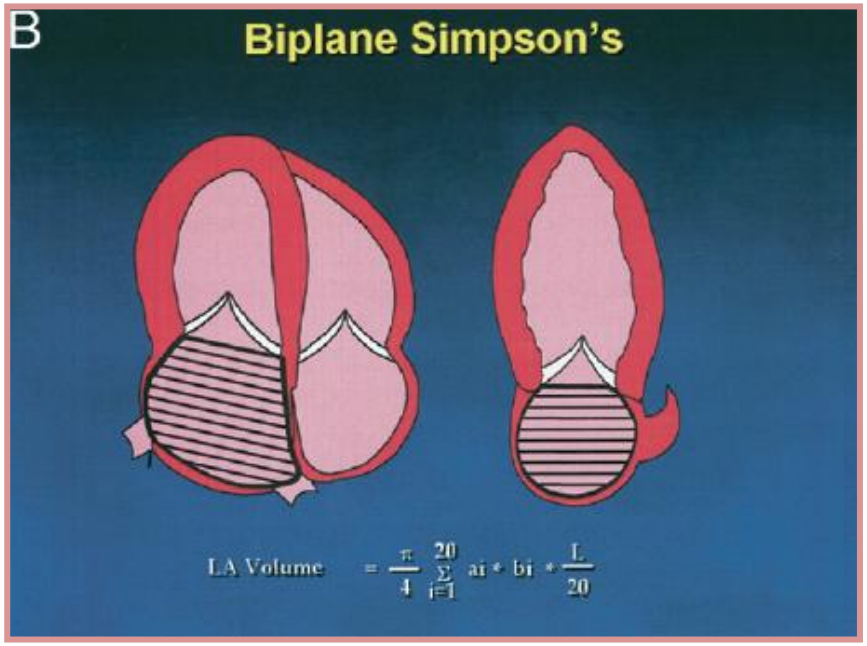
Restrictive

Normal > 50cm/sec
E/Vp >1.5 suggestive for high PCWP


Normal (Young)
Normal (Adult)
Stage 1* Impaired relaxation
Stage 2 Pseudonormal
Stage 3 Restrictive (reversible)
Stage 4 Restrictive (fixed)
Mitral inflow
E
A
Adur
Pulmonary venous flow
S
D
ARdur
AR
Mitral annulus velocity
s′
e′
a′
Color M-mode Doppler
Vp
LV relaxation
Normal
Impaired
Impaired
Impaired
Impaired
LV compliance
Normal
Normal or ↓
↓↓
↓↓↓
↓↓↓↓
LA pressure
Normal
Normal (1a) or ↑ (1b)
↑↑
↑↑↑
↑↑↑↑

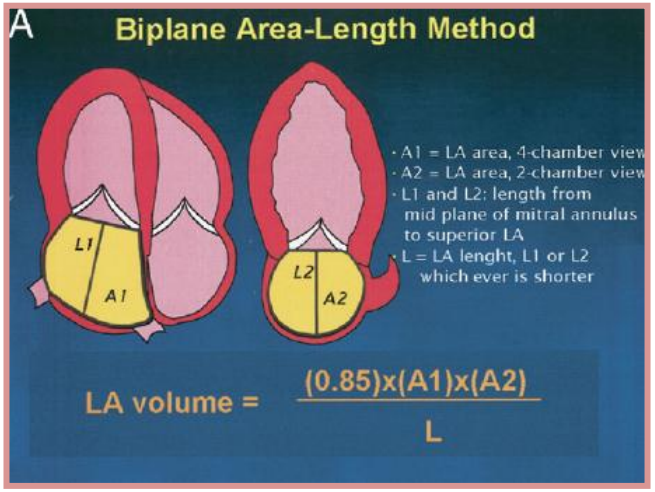
Over time, exposure of the LA to increased filling pressure will result in its remodeling





Left atrial volume is regarded as a "barometer" of the chronicity of diastolic dysfunction

LA volume is to diastolic function and to all forms of heart disease as the HbA1c is to diabetes.



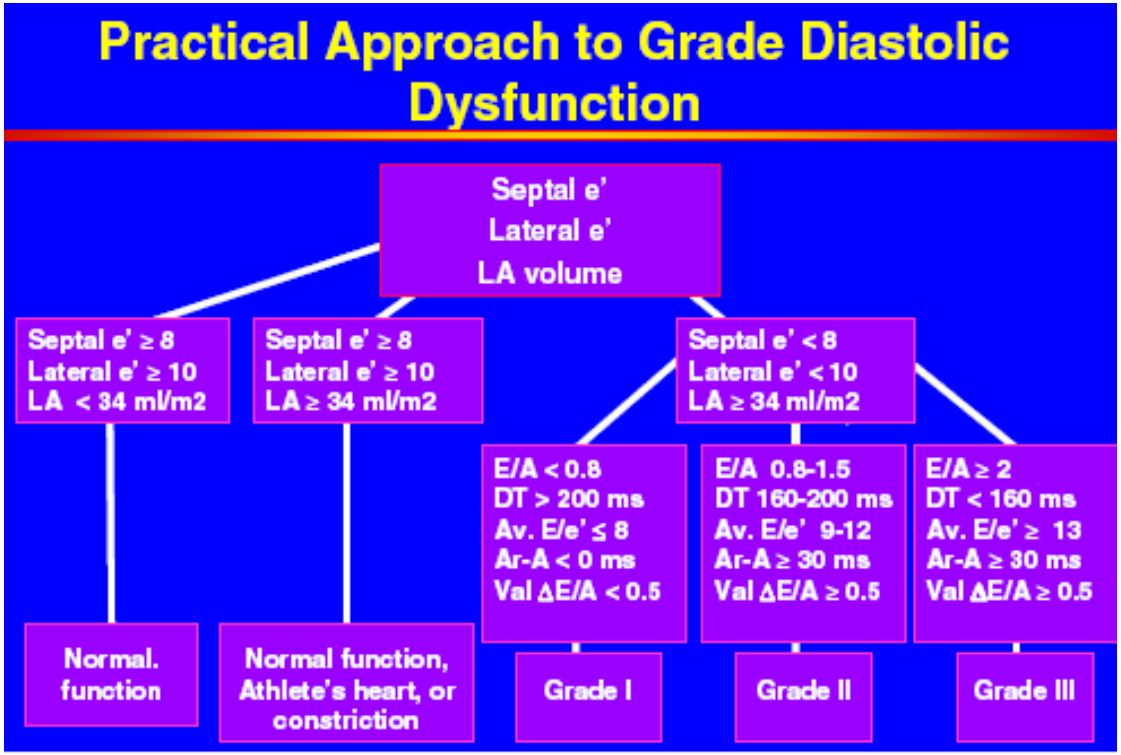
Measure of LA volume provides significant insight into an individual's risk for the development of adverse cardiovascular events (myocardialinfarction, stroke, atrial fibrillation, and heart failure)

Left atrial volume is graded relative to risk

- **Mild** 28 to 33ml/m2 mild
- **Moderate** 34to 39 ml/m2
- **High or Severe** ≥ 40ml/m2

GUIDELINES AND STANDARDS

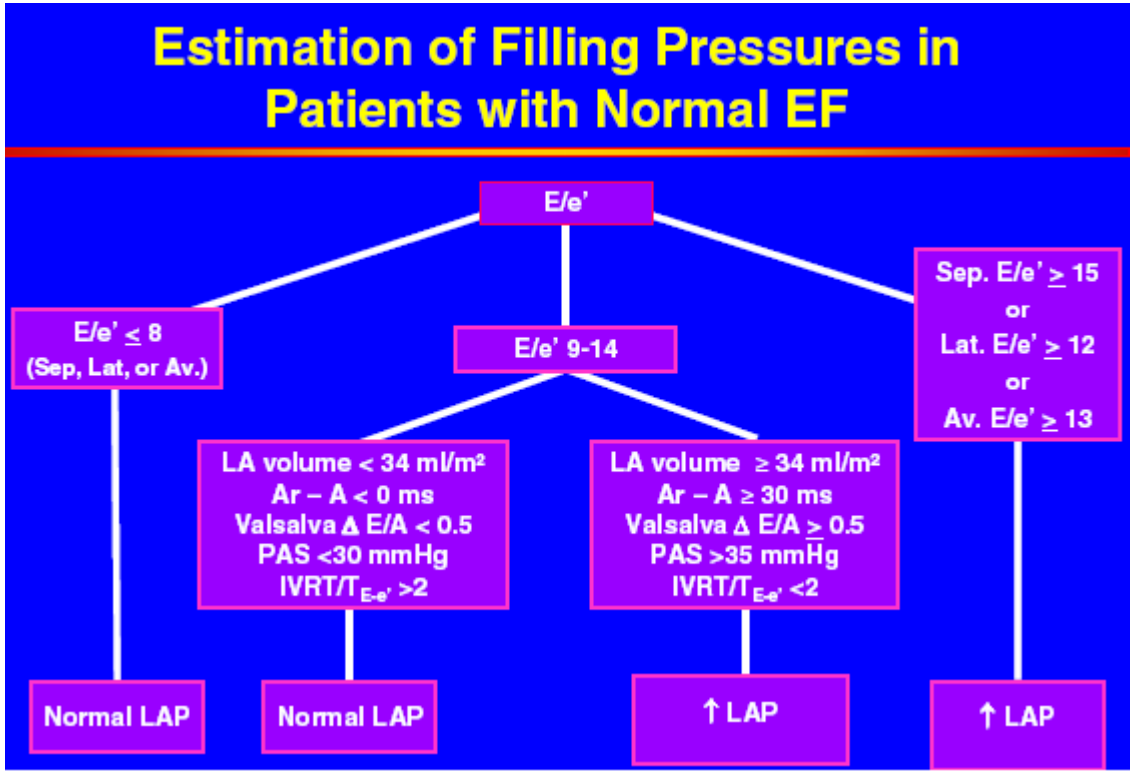
Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography



Nagueh SF JASE 2008

GUIDELINES AND STANDARDS

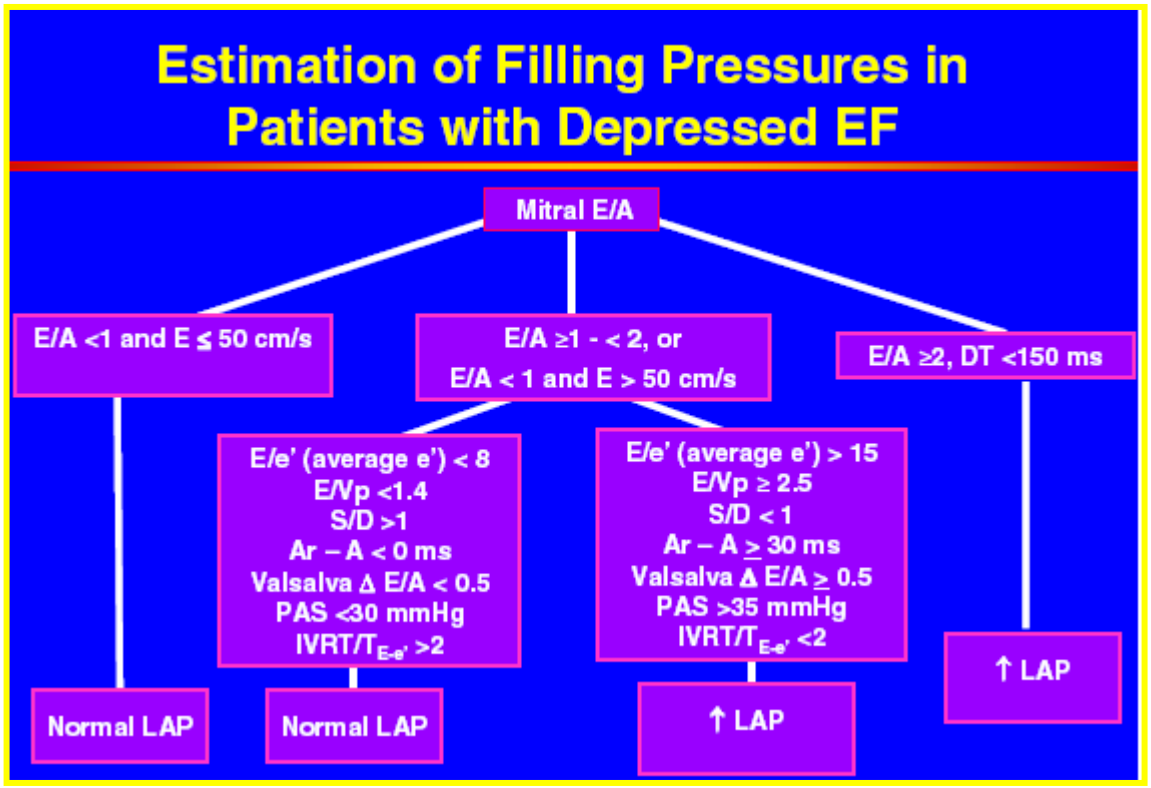
Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography



Nagueh SF JASE 2008

GUIDELINES AND STANDARDS

Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography



Nagueh SF JASE 2008

La Funzione Diastolica

Quali parametri ecocardiografici considerare?

Conclusioni