Echocardiography findings in HFNEF

DHF OR HFNEF

- Mauer et al.

Table 1. Examples of Heart Failure With Normal Left Ventricular Ejection Fraction

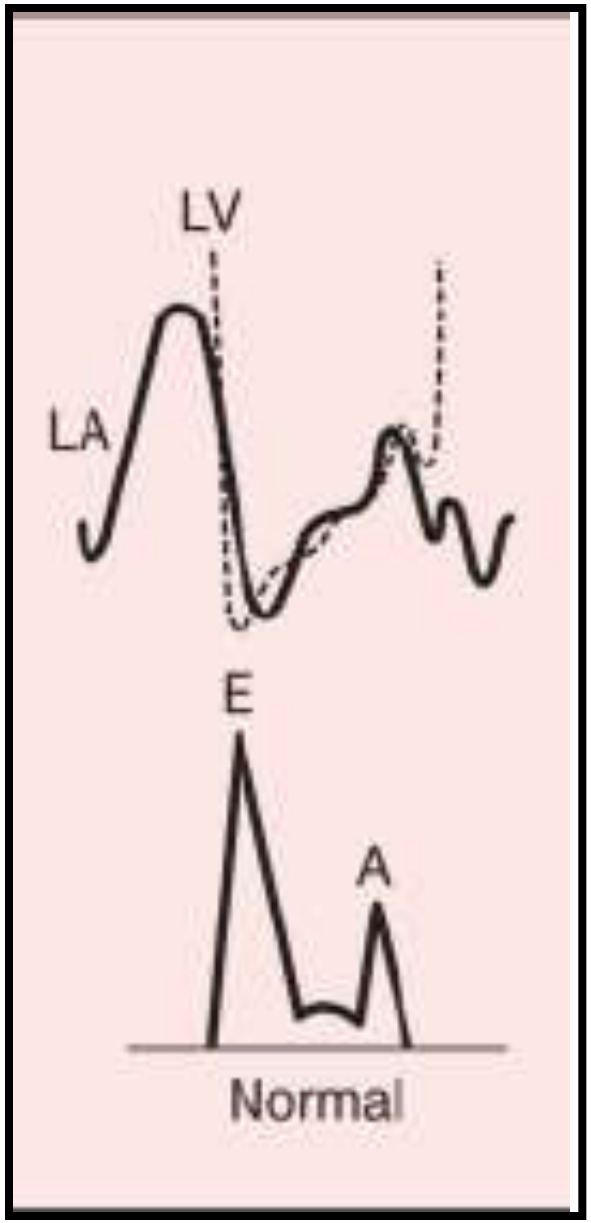
Diastolic heart failure
Hypertension
Restrictive cardiomyopathy
Infiltrative cardiomyopathy
Hypertrophic cardiomyopathy
Noncompaction cardiomyopathy
Right heart failure
Severe pulmonary hypertension
Right ventricular infarct
Arrhythmogenic right ventricular dysplasia
Atrial septal defect
Valvular heart diseases
Severe valvular stenosis
Severe valvular regurgitation
Pericardial disease
Cardiac tamponade
Constrictive pericarditis
Intracardiac mass
Atrial myxoma
Apical eosinophilic thrombus
Pulmonary vein stenosis
Congenital heart diseases

DHF

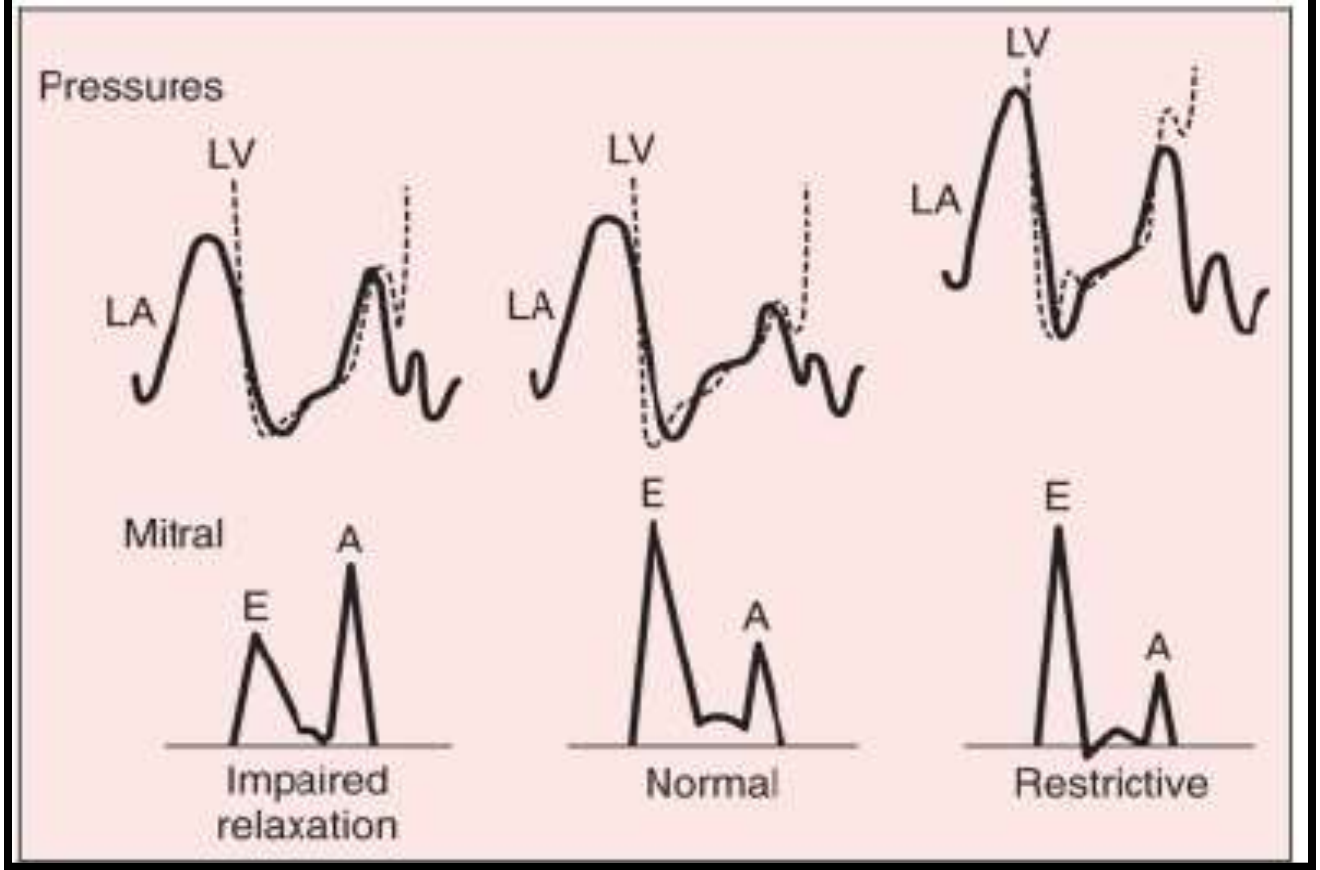
- LVEF is normal on two-dimensional echocardiography ✣ clinical evidence of heart failure.
- The diagnosis can be confirmed if Doppler echocardiography and myocardial tissue imaging.

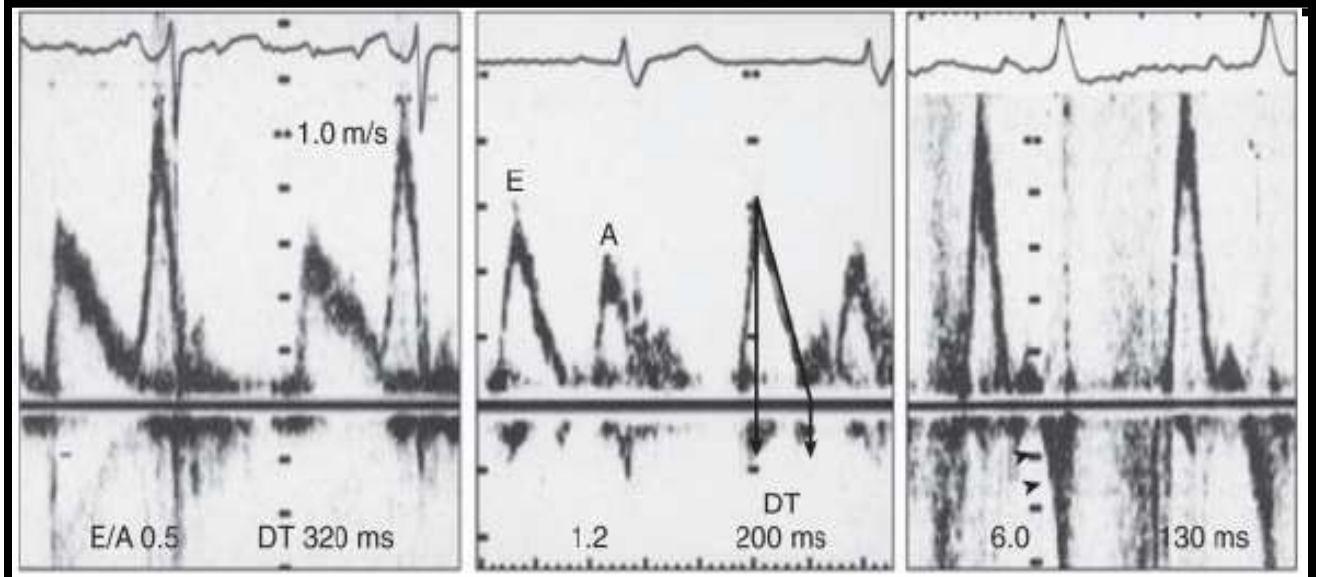
NORMAL AND ABNORMAL DIASTOLIC FUNCTION

- Normal diastolic function allows adequate filling of the ventricles during rest and exercise without abnormal increase in diastolic pressures.
- The normal response to exercise is lost in heart failure regardless of EF .
- Under these circumstances, relaxation of myocardium is slowed with decreased or no ability to enhance relaxation with exercise.
- Thus, LV early diastolic pressure does not decline during exercise but, in fact, increases.


LV
LA
E
A
Normal

- In patients with diastolic dysfunction, increases in LV filling in response to exercise are dependent on increases in left atrial pressure.
- Whether the LV filling is normal with a good myocardial relaxation or LV filling is dependent on left atrial pressure can be easily discerned by two-dimensional and Doppler parameters measured in a daily echocardiography practice, which are used to determine myocardial relaxation, compliance, and filling pressure at rest and with exercise.


Pressures
LV
LA
LV
LA
LV
LA
Mitral
E
A
E
A
E
A
Impaired relaxation
Normal
Restrictive


1.0 m/s
E/A 0.5
DT 320 ms
E
A
DT
1.2
200 ms
6.0
130 ms

HOW TO DETERMINE DIASTOLIC PROPERTY AND FILLING PRESSURE BY ECHOCARDIOGRAPHY

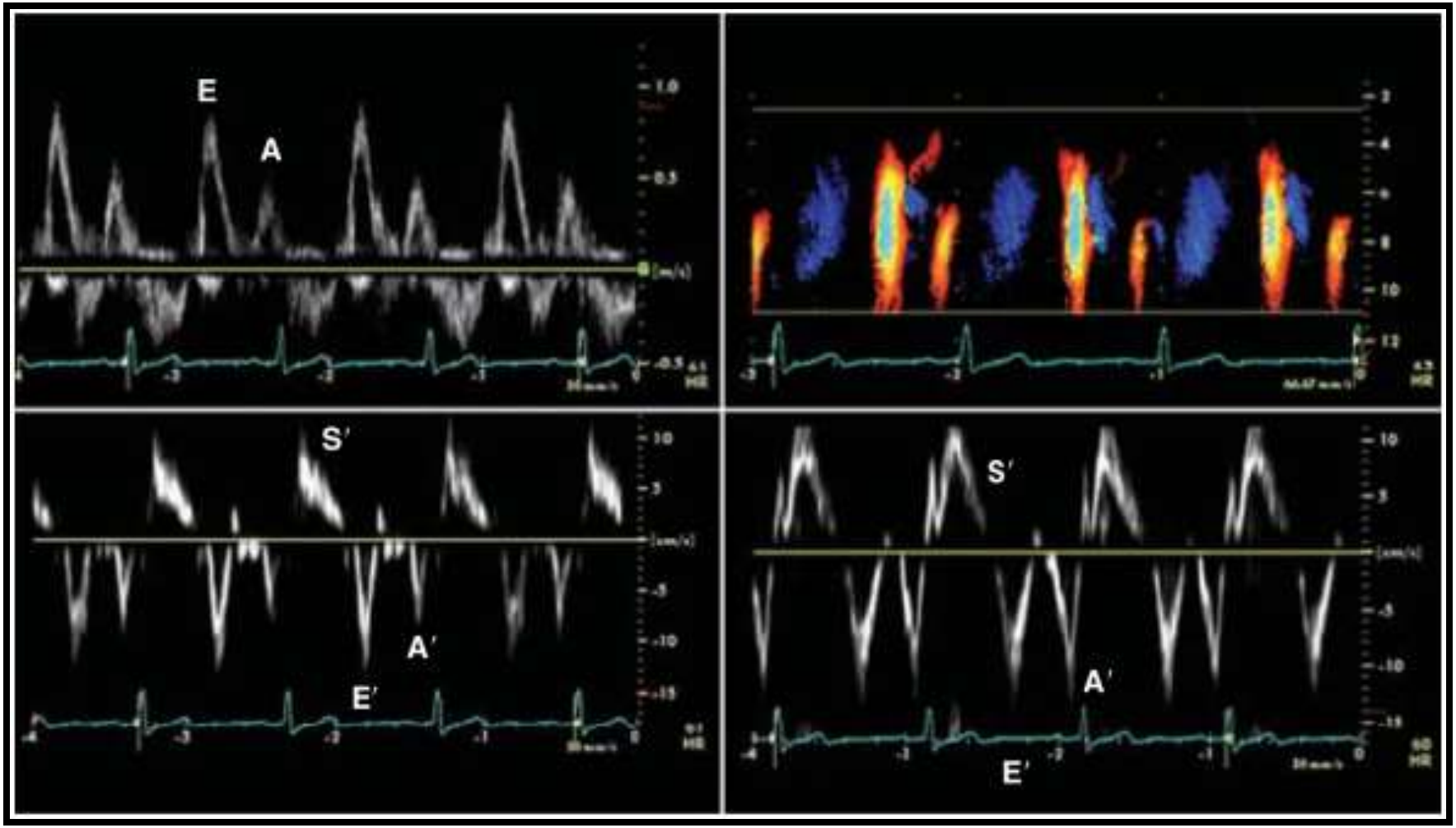
- Assessment of diastolic function should be an integral part of an evaluation of cardiac function because about 50 percent of patients with heart failure have a preserved LVEF.
- Currently, echocardiography is the best noninvasive way to evaluate diastolic function and to estimate filling pressures.

Comprehensive echocardiography

- M-mode,
- Two-dimensional,
- Doppler,
- Color M-mode, and
- Myocardial (tissue Doppler) imaging.

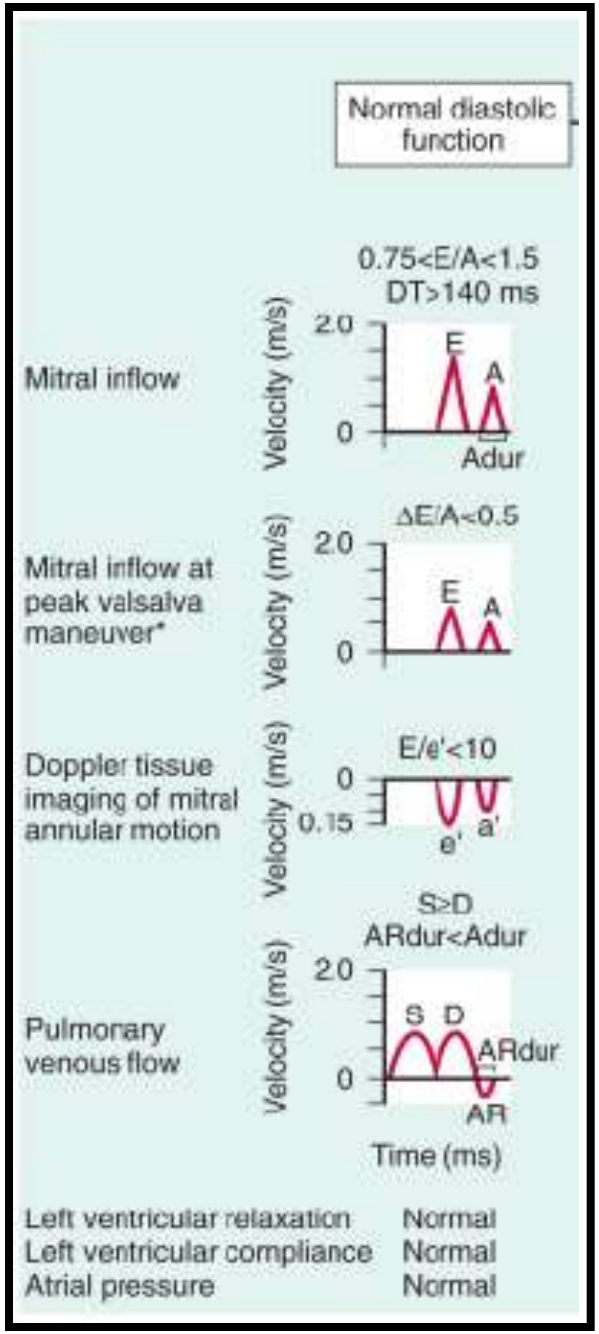
Two-dimensional echocardiography

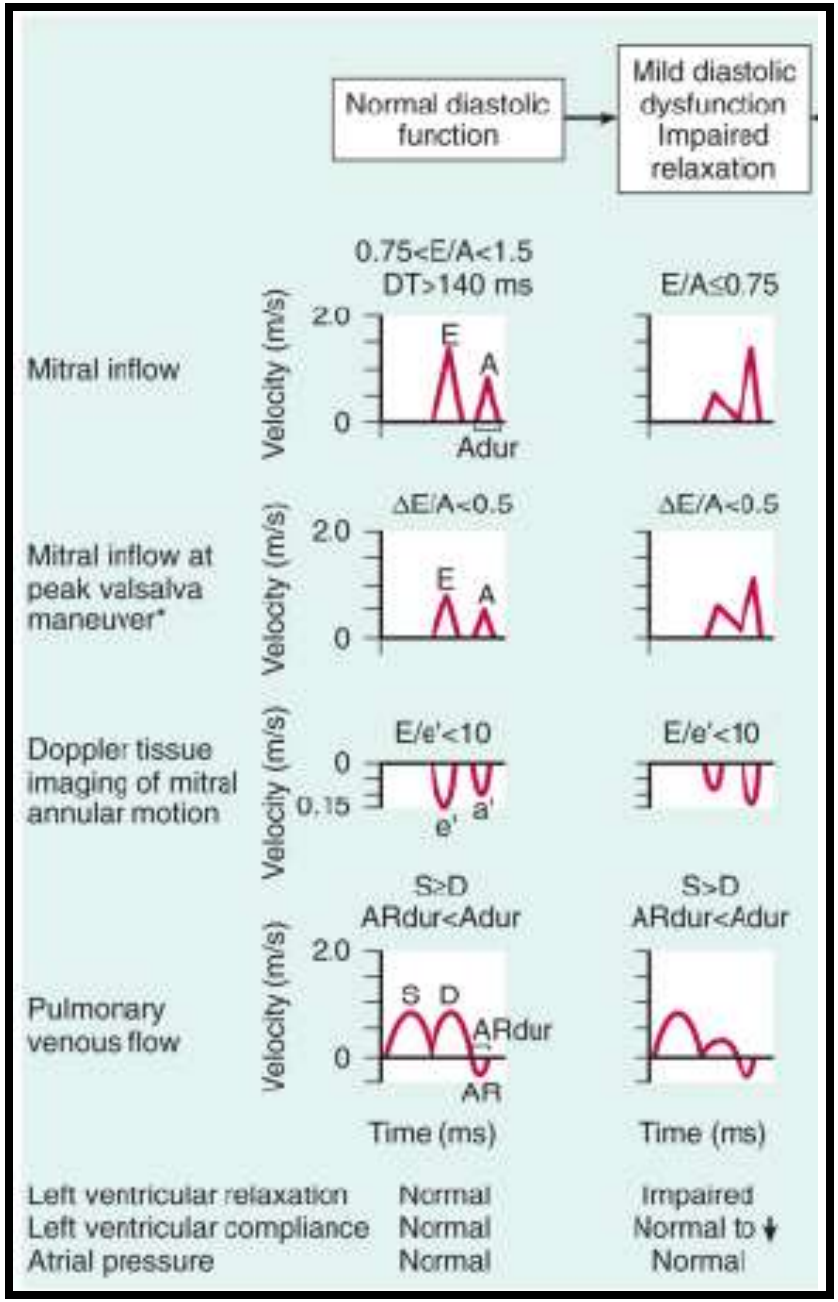
- LA size
- LV thickness
- LVEF
- Other structural heart diseases

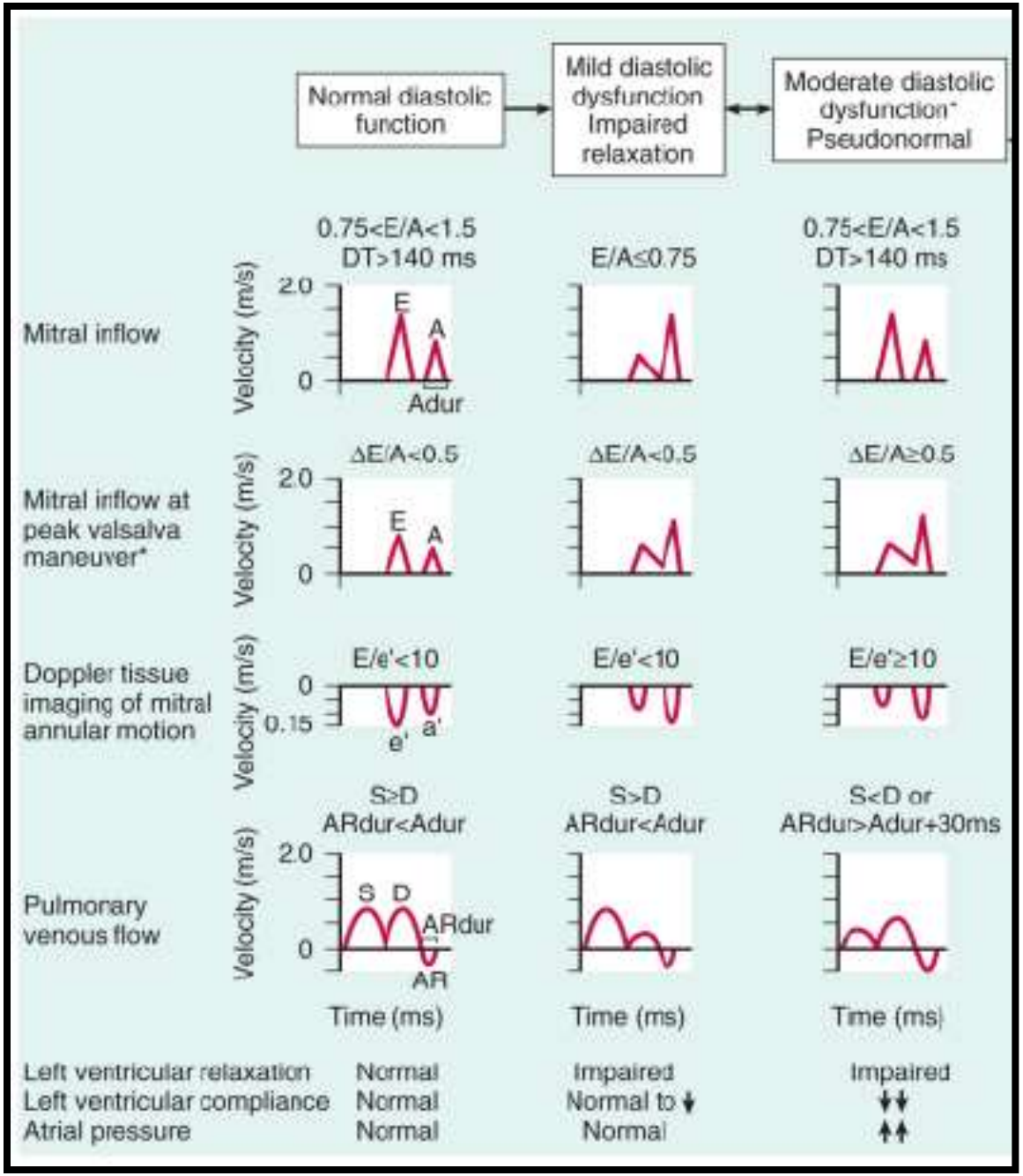

E
A
S′
A′
E′
S′
A′
E′

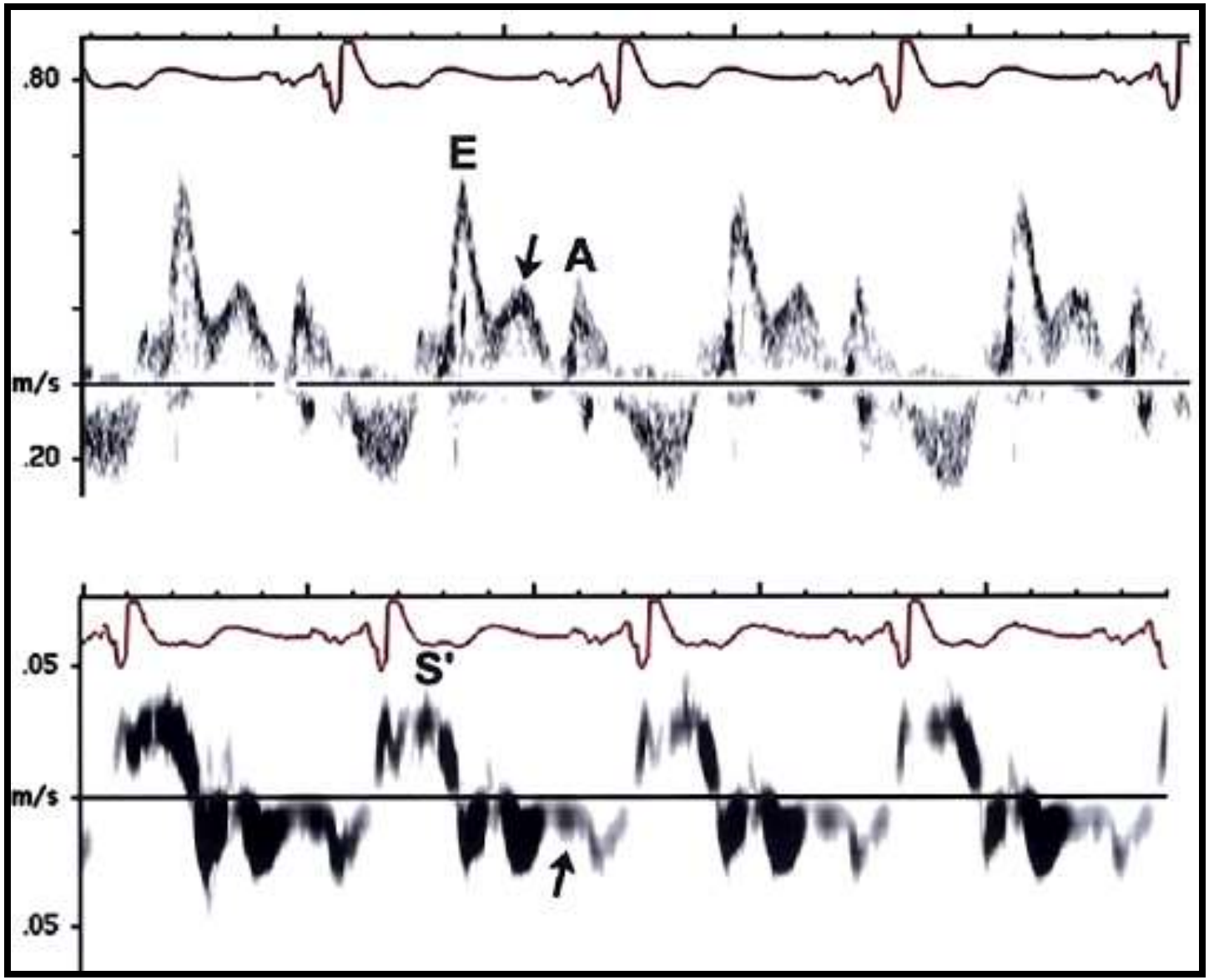
Diastolic Heart Failure - Comprehensive Two-Dimensional and Doppler Echocardiography

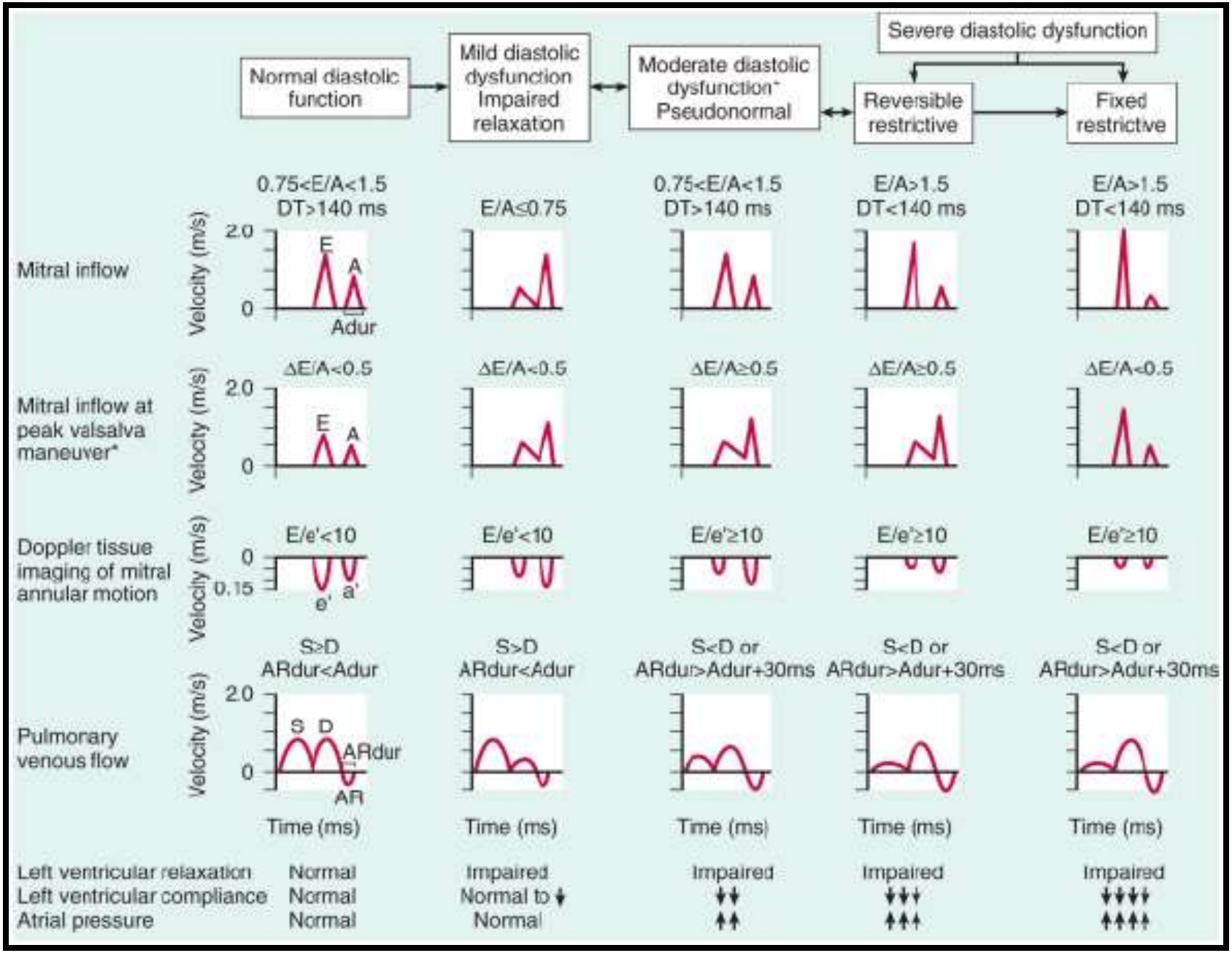
- Impaired myocardial relaxation
  - -decreased longitudinal velocity of the mitral annulus during early diastole (Ea) and
  - -decreased propagation velocity mitral inflow (Vp),
- Decreased compliance
  - -shortened mitral A-wave duration and
  - -mitral deceleration time (DT),
- Increased filling pressure
  - -shortened isovolumic relaxation time (IVRT) and
  - -an increased ratio between early diastolic mitral and mitral annular velocities (E/Ea).

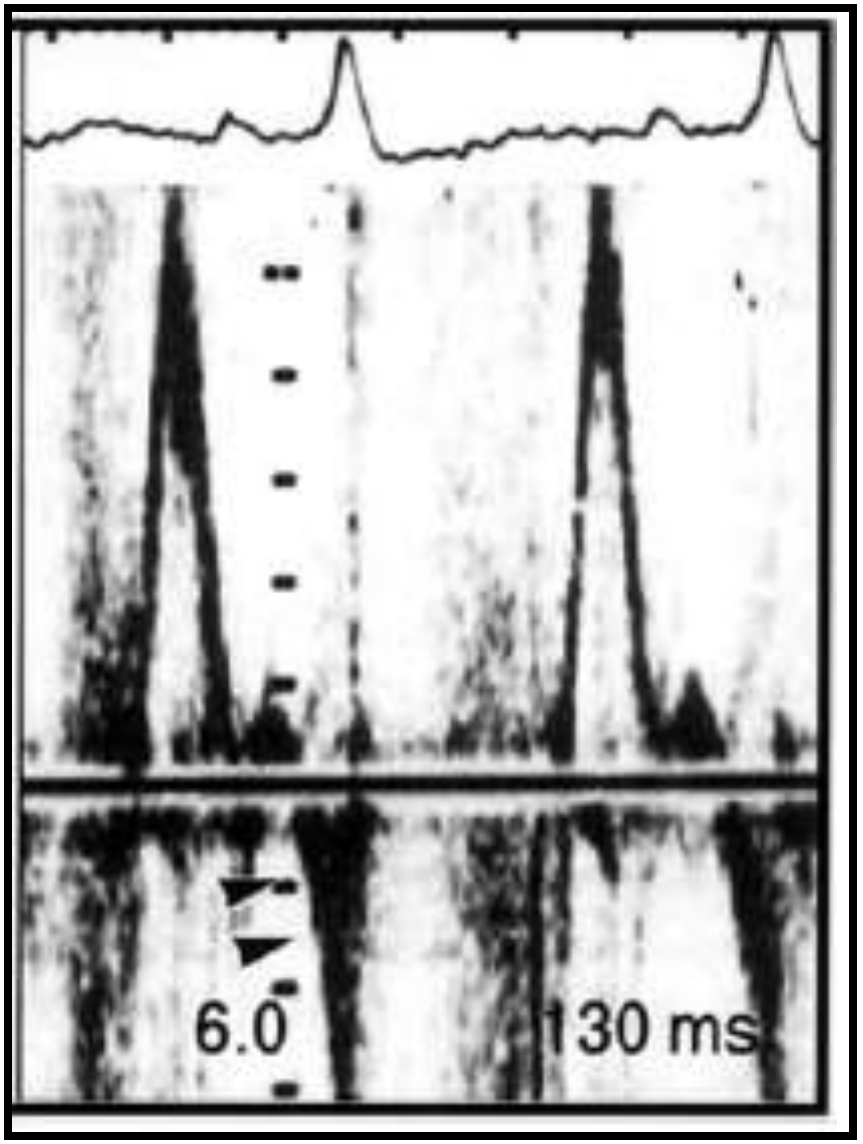

Normal diastolic function
0.75<E/A<1.5
DT>140 ms
Mitral inflow
Velocity (m/s)
2.0
0
E
A
Adur
ΔE/A<0.5
Mitral inflow at peak valsalva maneuver*
Velocity (m/s)
2.0
0
E
A
E/e'<10
Doppler tissue imaging of mitral annular motion
Velocity (m/s)
0
0.15
e'
a'
S>D
ARdur<Adur
Pulmonary venous flow
Velocity (m/s)
2.0
0
S
D
ARdur
AR
Time (ms)
Left ventricular relaxation Normal
Left ventricular compliance Normal
Atrial pressure Normal

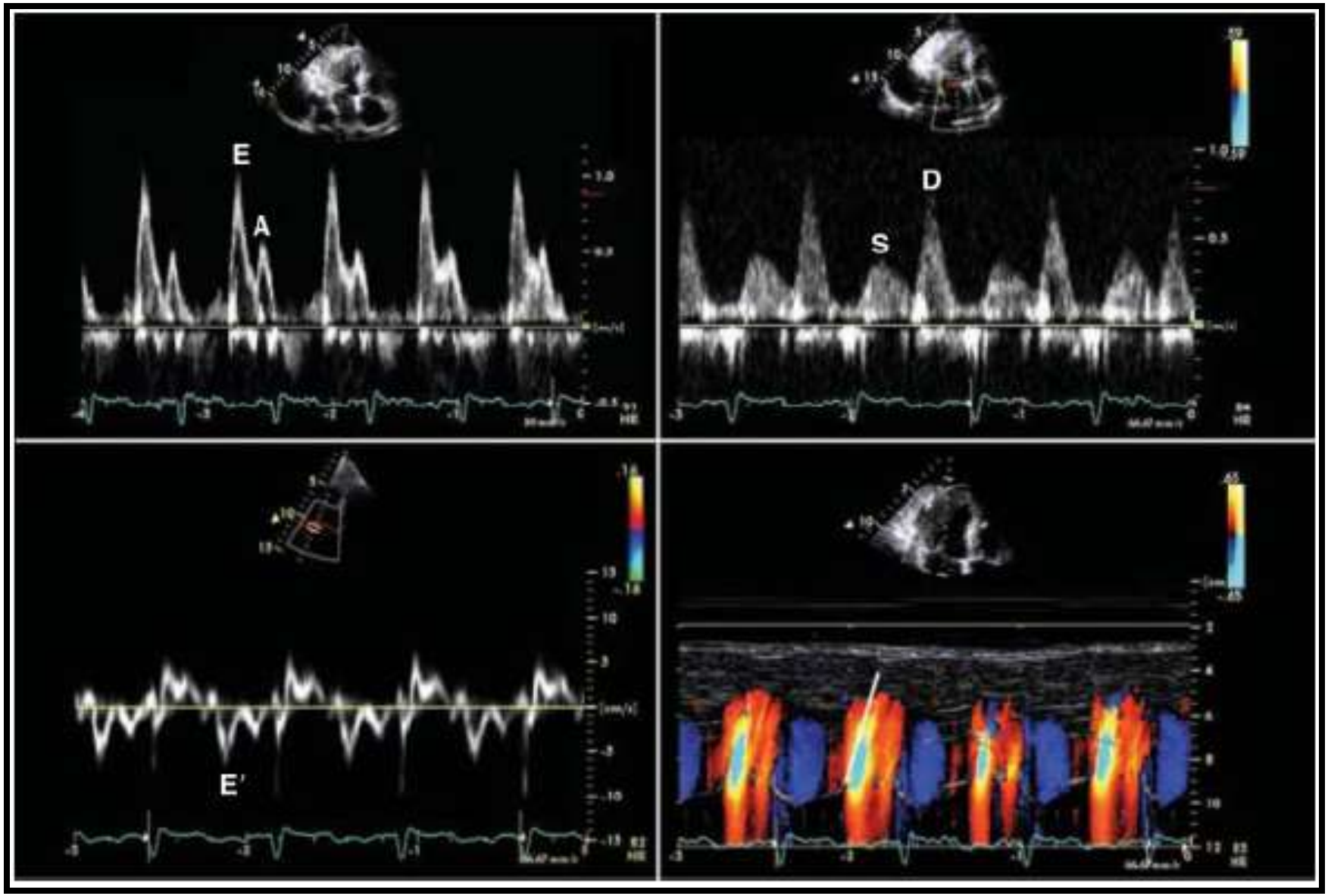

Normal diastolic function
Mild diastolic dysfunction Impaired relaxation
0.75<E/A<1.5
DT>140 ms
E/A≤0.75
Mitral inflow
Velocity (m/s)
2.0
0
E
A
Adur
ΔE/A<0.5
ΔE/A<0.5
Mitral inflow at peak valsalva maneuver*
E/e'<10
E/e'<10
Doppler tissue imaging of mitral annular motion
0
0.15
e'
a'
S>D
ARdur<Adur
S>D
ARdur<Adur
Pulmorary venous flow
S
D
ARdur
AR
Time (ms)
Time (ms)
Left ventricular relaxation Normal Impaired
Left ventricular compliance Normal Normal to ↓
Atrial pressure Normal Normal

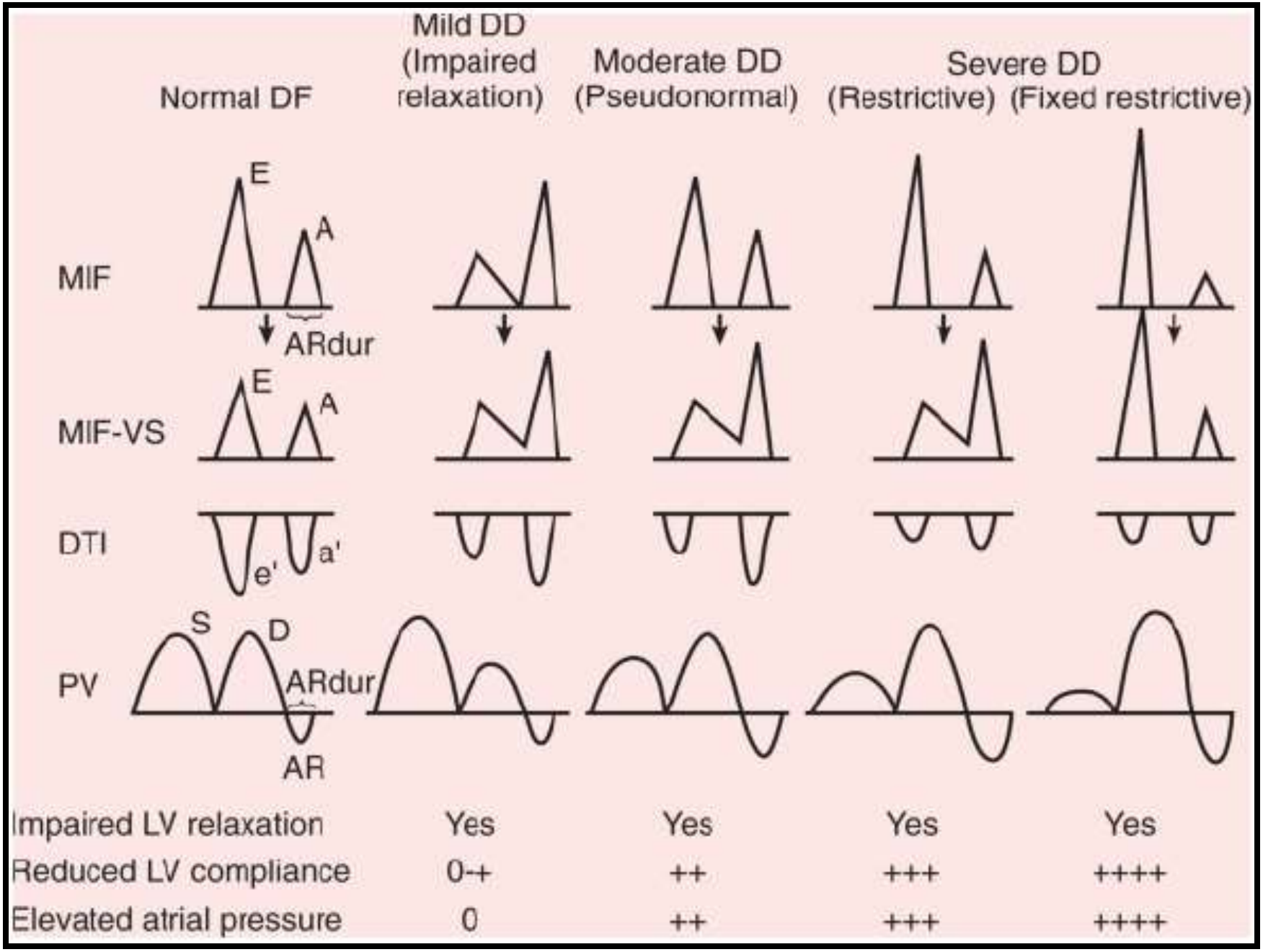

Normal diastolic function
Mild diastolic dysfunction Impaired relaxation
Moderate diastolic dysfunction* Pseudonormal
0.75<E/A<1.5
DT>140 ms
E/A≤0.75
0.75<E/A<1.5
DT>140 ms
Mitral inflow
Velocity (m/s)
2.0
0
E
A
Adur
ΔE/A<0.5
ΔE/A<0.5
ΔE/A≥0.5
Mitral inflow at peak valsalva maneuver*
E/e'<10
E/e'<10
E/e'≥10
Doppler tissue imaging of mitral annular motion
0
0.15
e'
a'
S>D
ARdur<Adur
S>D
ARdur<Adur
S<D or
ARdur>Adur+30ms
Pulmonary venous flow
S
D
ARdur
AR
Time (ms)
Time (ms)
Time (ms)
Left ventricular relaxation
Left ventricular compliance
Atrial pressure
Normal
Normal
Normal
Impaired
Normal to ↓
Normal
Impaired
↓↓
↑↑


.80
E
A
m/s
.20
.05
S'
m/s
.05


Normal diastolic function
Mild diastolic dysfunction Impaired relaxation
Moderate diastolic dysfunction* Pseudonormal
Severe diastolic dysfunction
Reversible restrictive
Fixed restrictive
Mitral inflow
0.75<E/A<1.5 DT>140 ms
E/A≤0.75
0.75<E/A<1.5 DT>140 ms
E/A>1.5 DT<140 ms
E/A>1.5 DT<140 ms
Velocity (m/s)
2.0
0
E
A
Adur
Mitral inflow at peak valsalva maneuver*
ΔE/A<0.5
ΔE/A<0.5
ΔE/A≥0.5
ΔE/A≥0.5
ΔE/A<0.5
Doppler tissue imaging of mitral annular motion
E/e'<10
E/e'<10
E/e'≥10
E/e'≥10
E/e'≥10
0
0.15
e'
a'
Pulmonary venous flow
S>D ARdur<Adur
S>D ARdur<Adur
S<D or ARdur>Adur+30ms
S<D or ARdur>Adur+30ms
S<D or ARdur>Adur+30ms
S
D
ARdur
AR
Time (ms)
Left ventricular relaxation Normal Impaired Impaired Impaired Impaired
Left ventricular compliance Normal Normal to ↓ ↓↓ ↓↓↓ ↓↓↓↓
Atrial pressure Normal Normal ↑↑ ↑↑↑ ↑↑↑↑


6.0
130 ms


E
A
D
S
E'


Normal DF
Mild DD (Impaired relaxation)
Moderate DD (Pseudonormal)
Severe DD (Restrictive)
(Fixed restrictive)
MIF
E
A
ARdur
MIF-VS
E
A
DTI
e'
a'
PV
S
D
ARdur
AR
Impaired LV relaxation Yes Yes Yes Yes
Reduced LV compliance 0-+ ++ +++ ++++
Elevated atrial pressure 0 ++ +++ ++++