EAE Teaching Course
Sofia, 2012

Diastolic Function

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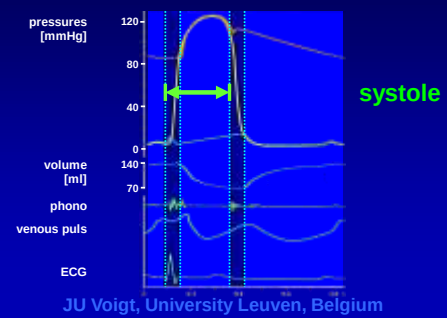
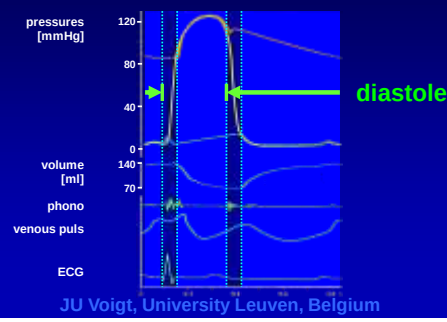
Diastolic Function

What is that?

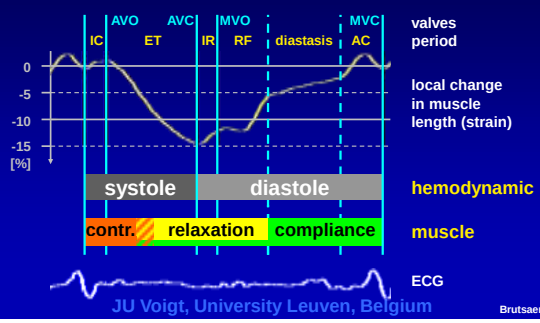
Defining Systole



Defining Diastole



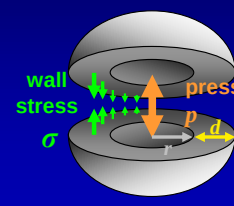
Defining Diastole



Brutsaert 1985

Wall Stress vs. Cavity Pressure

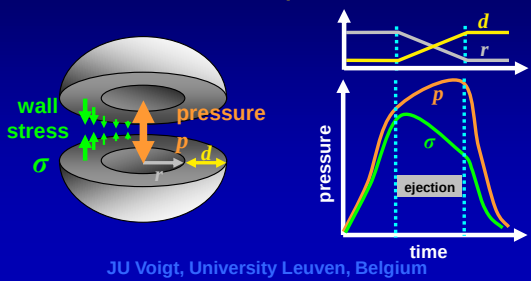
law of Laplace



$$\sigma = p \cdot \frac{r}{2d}$$

Wall Stress vs. Cavity Pressure

law of Laplace



Diastolic Function

complex interaction of:

- compliance
- relaxation
- loading
- energy supply

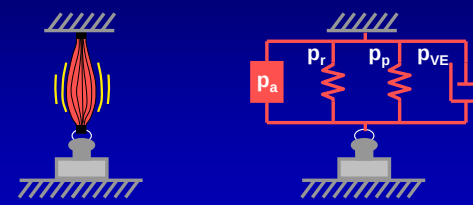
... allowing adequate filling of the ventricle

Diastole

Determinants of Diastolic Function

Diastole

Model of LV Myocardium

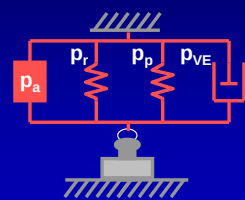


Diastole

Model of LV Myocardium

active elements
- p_a - actin / myosin

passive elements
- p_r - elasticity
  chamber restoring forces
  torsion
- p_p - EDPVR
  ustressed volume equlibrium
- p_{VE} - viscoelasticity
  flow / heart rate dependent



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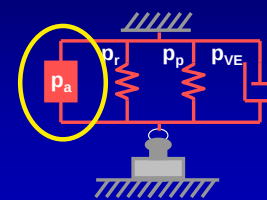
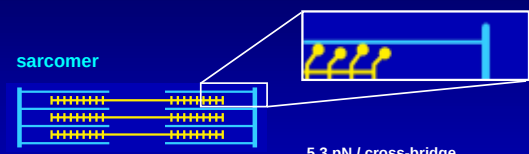


Diastolic Function

active: detachment of actin - myosin - bridges



5.3 pN / cross-bridge

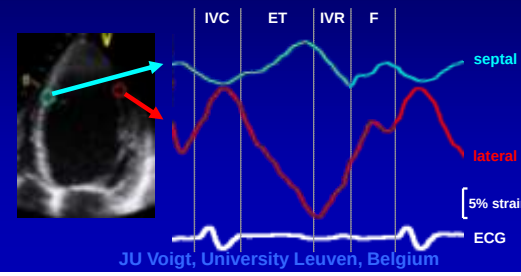
100 cross-bridges / filament

$5.7*10^{10}$ filaments / cm^2

30 N/cm^2 (≈ 3 kg/cm^2)

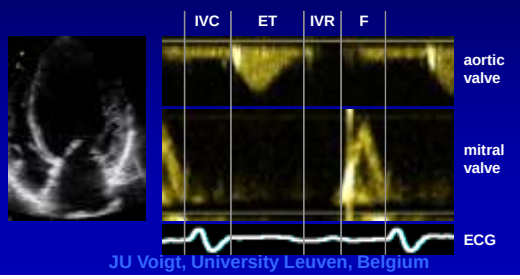
Diastolic Function

asynchronous activation / inactivation



Diastolic Function

asynchronous activation / inactivation



Diastole

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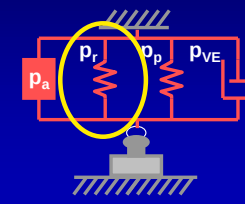
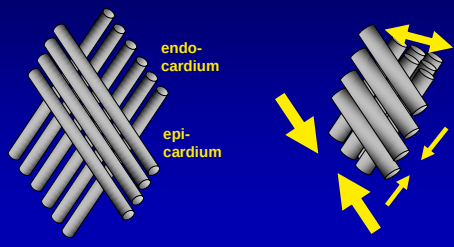


Myocardial Fibre Architecture

fibre / cross fibre shortening



adapted from: Rademakers et al., Circ '94

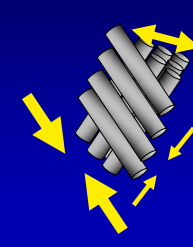
Relaxation

passive: restoring forces

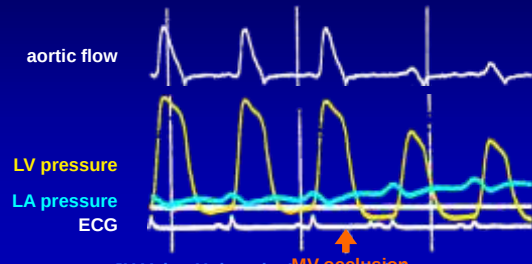
- cross fibre shortening

- structural level
  - collagen between fibres and muscle layers
  - titin in myocytes

- external modulation
  - erectile function of coronary perfusion (?)
  - filling pressure (pathologic)



Diastolic Haemodynamics



Diastole

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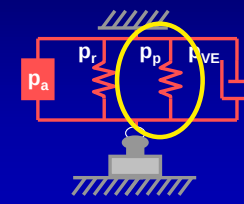


Definitions

Compliance

$$C = \frac{\Delta volume}{\Delta pressure}$$

Stiffness

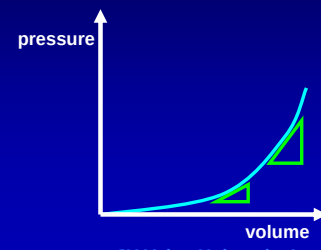
$$E = \frac{stress}{strain}$$

synonyms:

Young's modulus
modulus of elasticity
elastic modulus

The Ventricle

pressure – volume - relation



passive tension

passive properties are pressure and volume dependent !

Diastolic Function

How to Assess it?

Diastolic Function

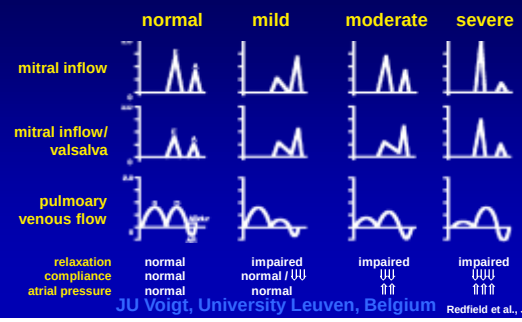
traditional indices:

mitral inflow

pulmonry vein inflow

morphology
- LV wall motion / EF
- LV size / wall thickness
- LA size

Diastolic Dysfunction



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Redfield et al., JAMA 2003

Traditional Diastolic Parameters

biphasic response

IVRT :	↑↑	↓↓
E:A :*	↓↓	↑↑
DecT:*	↑↑	↓↓

* E:A ↑↑ and DecT ↓↓ may occur in young people with good function !

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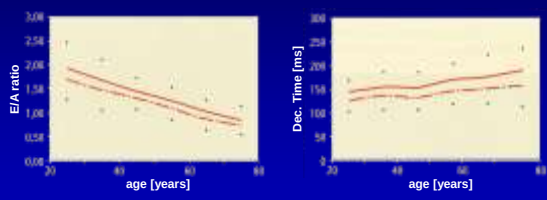
Mitral Inflow Profile

age dependence



always uncertainty

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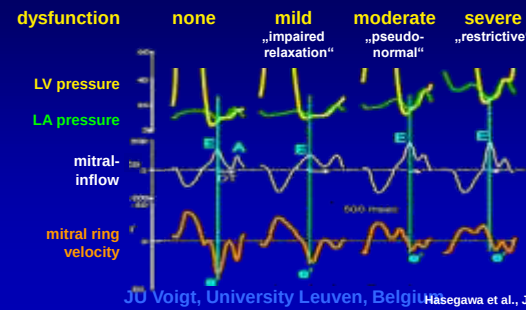
Diastolic Dysfunction



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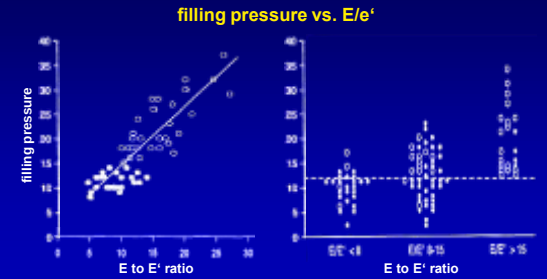
Hasegawa et al., JACC 2003

Estimating Filling Pressure

filling pressure vs. E/e‘



Nagueh et al., JACC 1997

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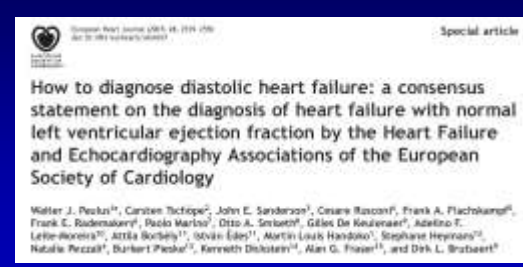
Ommen et al., Circulation 2000

E/e‘ in Recommendations



Special article

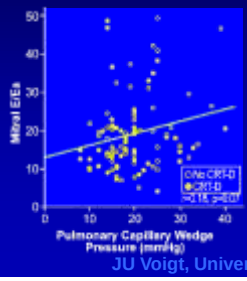
How to diagnose diastolic heart failure: a consensus statement on the diagnosis of heart failure with normal left ventricular ejection fraction by the Heart Failure and Echocardiography Associations of the European Society of Cardiology

JU Voigt, University Leuven, Belgium

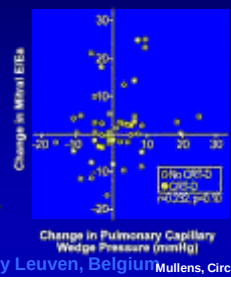
Eur Heart J 2007; 28, 2539-50

E/e‘ and Diastolic Function

E/e‘ vs. filling pressure



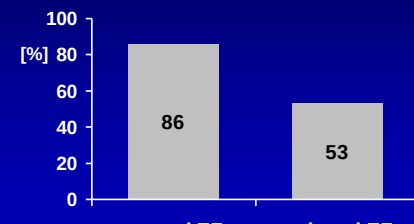
Δ E/e‘ vs. Δ filling pressure



Mullens, Circulation 2009

E/e’ and Systolic LV Function

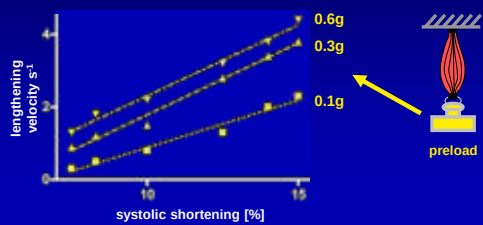
correct detection of PCWP > 18mmHg



Tschöpe et al., Circ 2009

Diast. Lengthening Velocity

Depends on systolic function and preload !



Goethals et al., Am J Physiol 1982

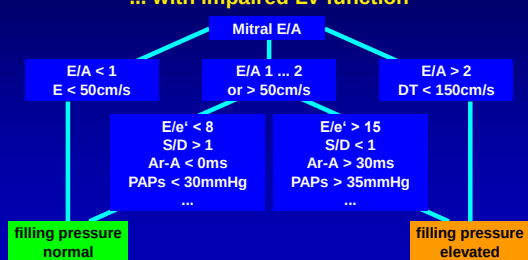
E/e‘ and Diastolic Dysfunction

E/e’ is unreliable in:

- normal healthy people
- overfilling
- mitral stenosis / ~insufficiency
- hypertrophic cardiomyopathy
- bad LV function / CAD
- bundle branch blocks / CRT
- constrictive pericarditis

Estimation of Filling Pressures

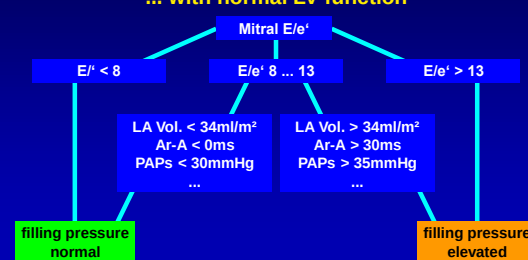
... with impaired LV function



EAE / ASE Recommendations (Nagueh et al., Eur J Echocardiogr 2009)

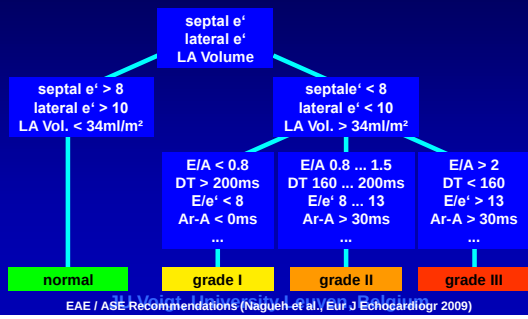
Estimation of Filling Pressures

... with normal LV function



EAE / ASE Recommendations (Nagueh et al., Eur J Echocardiogr 2009)

Assessment of Diastolic Function

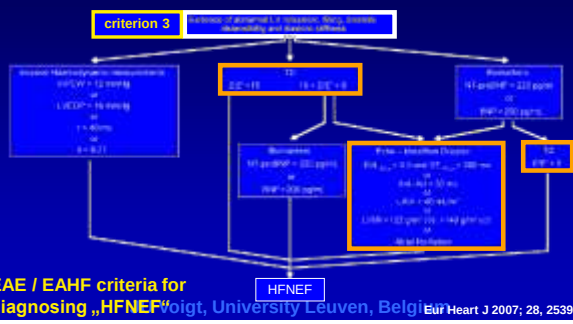


EAE / ASE Recommendations (Nagueh et al., Eur J Echocardiogr 2009)

Diastolic Function

Why measuring it?

Diastolic Function and Diagnosis



EAE / EAHF criteria for diagnosing „HFNEF"

Eur Heart J 2007; 28, 2539-50

Summary

Diastolic function of the LV
is complex and multifactorially determined.

No Doppler-echocardiographic parameter allone
allows a reliable diagnosis of
elevated filling pressures in all cases.

The assessment of diastolic dysfunction
is often difficult and
rarely influences clinical decision making.

Diastolic function assessment should always consider
all available echocardiographic parameters
and clinical information.