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University of Brescia, Italy

Hypertension and diastolic dysfunction

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How to assess diastolic dysfunction

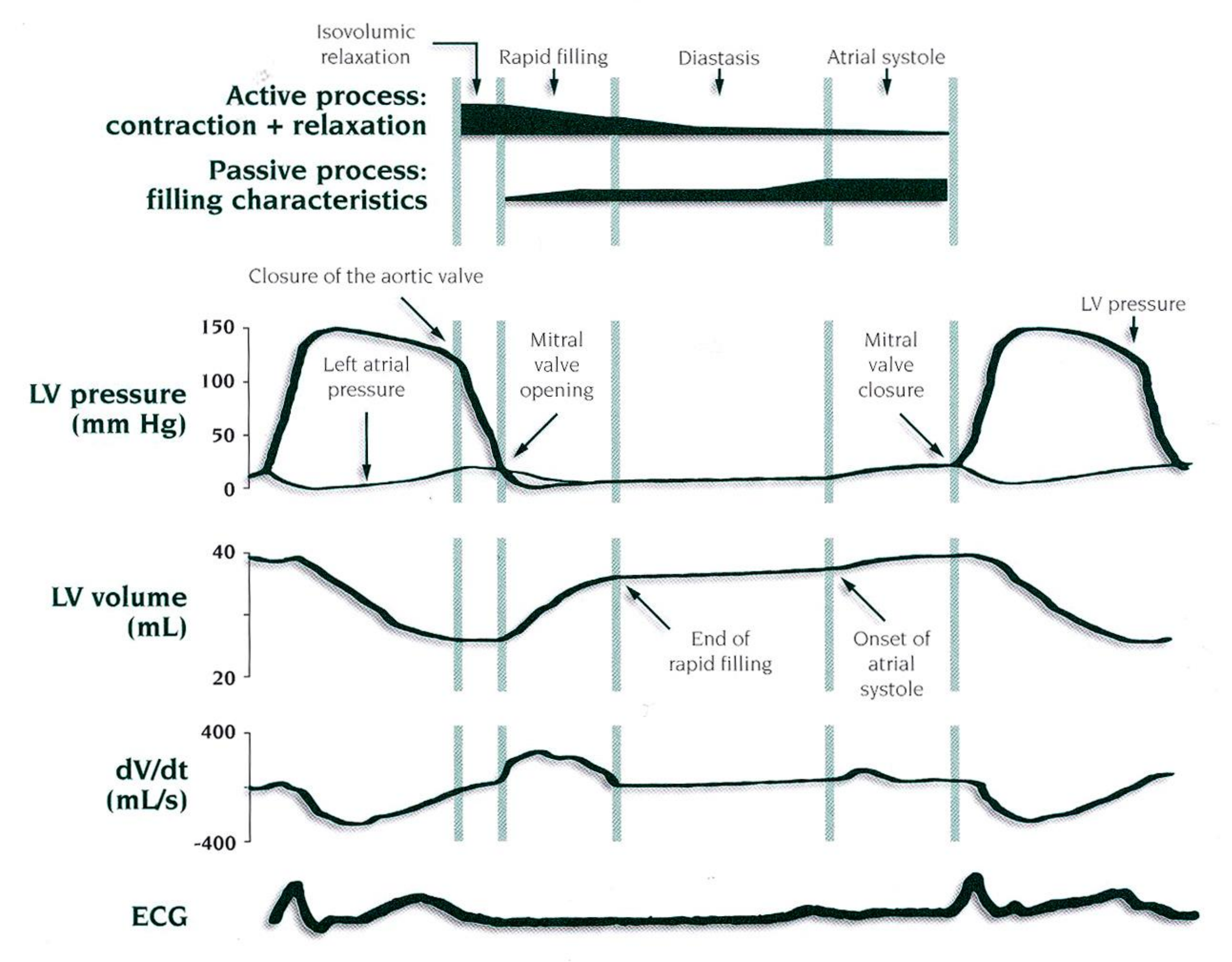
Determinants of diastolic dysfunction

Prognostic value of diastolic dysfunction

Characteristics of diastolic heart failure

Treatment of diastolic dysfunction

Pressure-volume relation



Invasive techniques

	Parameter	Limits of normal values
Relaxation	τ -dP/dt	> 48 ms < 1100 mmHg . s^{-1}
Diastolic filling	PFR, istantaneous filling rate time to peak filling	< 160ml . $s^{-1.}$ m^{-2}
Distensibility	LV EDP PWCP	< 16 mmHg < 12 mmHg
Passive function	Constant of chamber stiffness, b	> 0.27
	Myocardial stress-strain relation, b1	> 16

Non - invasive techniques

- 2D – and Doppler-echocardiography
- radionuclide ventriculography
- MR imaging

Diastolic filling abnormalities

– quantitative echocardiography

- M-mode LV and LA echo (atrial filling fraction)
- Transmitral flow E and A vel
- E deceleration
- IVRT
- Pulmonary flow velocities

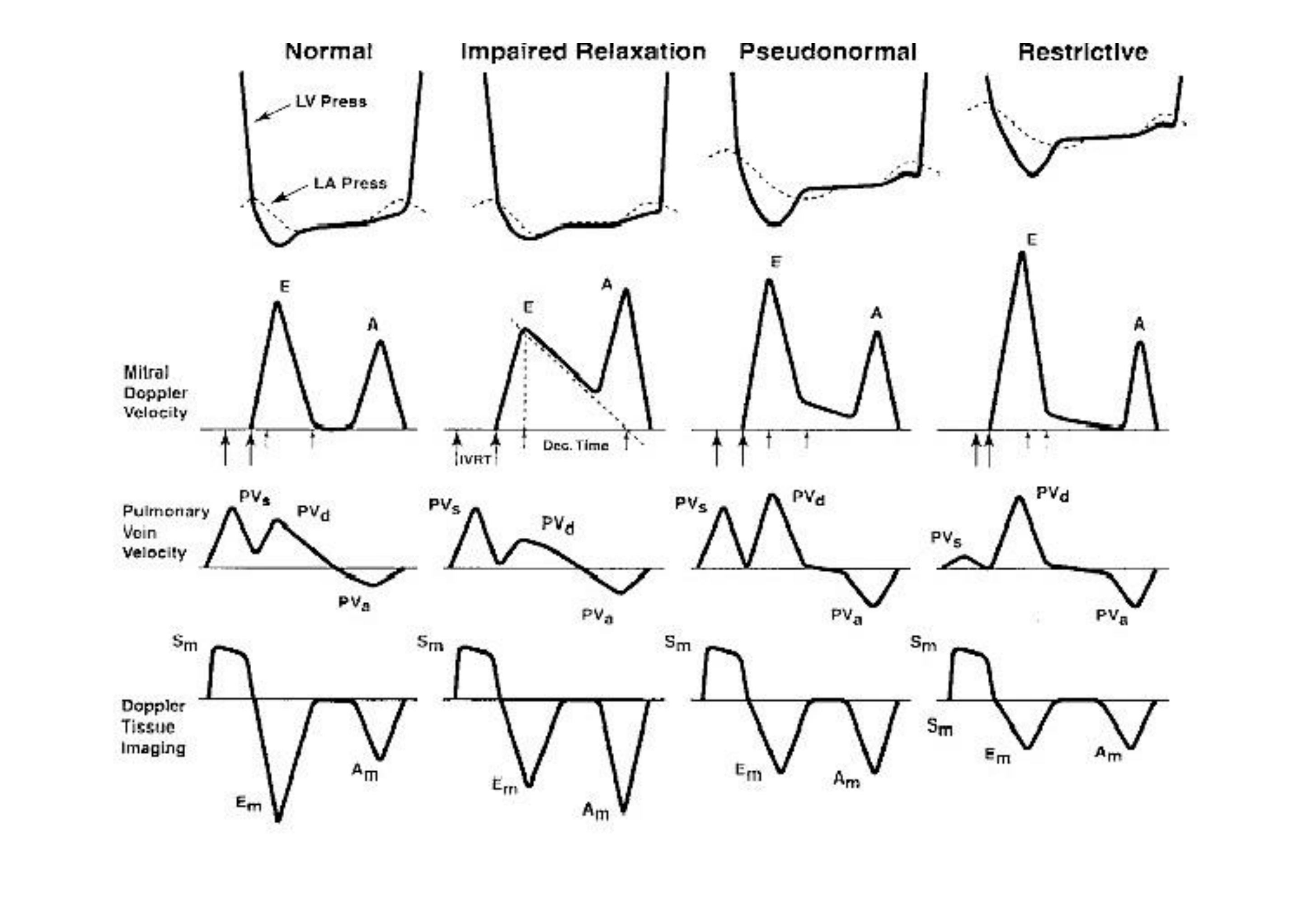
– Doppler color flow M-mode

- Flow-propagation velocities

– Doppler tissue imaging

- Myocardial velocities

Diastolic filling by Doppler echocardiography



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Diastolic dysfunction

LV relaxation abnormalities

Hypertension
Ischemia
Hypertrophy
Cardiomyopathies
High output states
Overload
Aging

Altered passive elastic properties

Hypertension
Hypertrophy
Aging
Altered collagen composition
Diabetes mellitus
Fibrosis
Infiltrative myocardial disease
Storage myocardial disease
Endomyocardial disease
Pericardial disease

The Strong Heart Study

Diastolic filling parameters adjusted for age, HR, LV mass, MFS

	No HT or DM n 730 age 58 yrs	**HT** n 394 age 61 yrs	**DM** n 616 age 58 yrs	**HT & DM** n 671 age 61 yrs
E/A ratio	**0.89± 0.008*#**	**0.83 ± 0.011§**	**0.83 ± 0.009 §**	**0.79 ± 0.009 #*§**
E dec cm/sec	**197 ± 2.5 *#**	**203 ± 3 §***	**202 ± 3 §#**	**212 ± 3 #*§**

* Vs DM, § vs no HT-DM; # vs HT

Liu et al JACC 2001; 37: 1943

Diastolic dysfunction can be found in 25% of asymptomatic hypertensives without LV hypertrophy, but in 90% of those having LV hypertrophy

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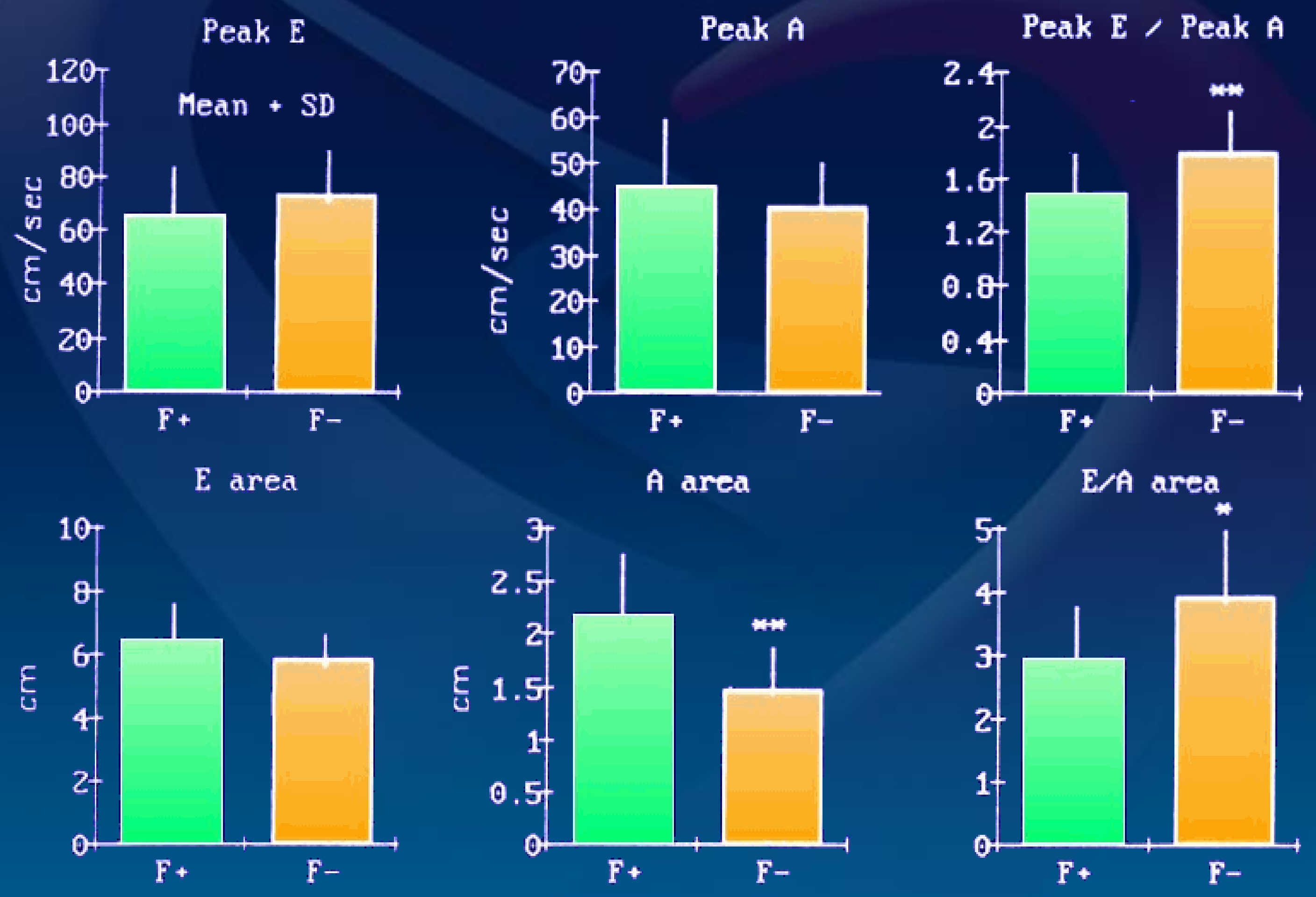
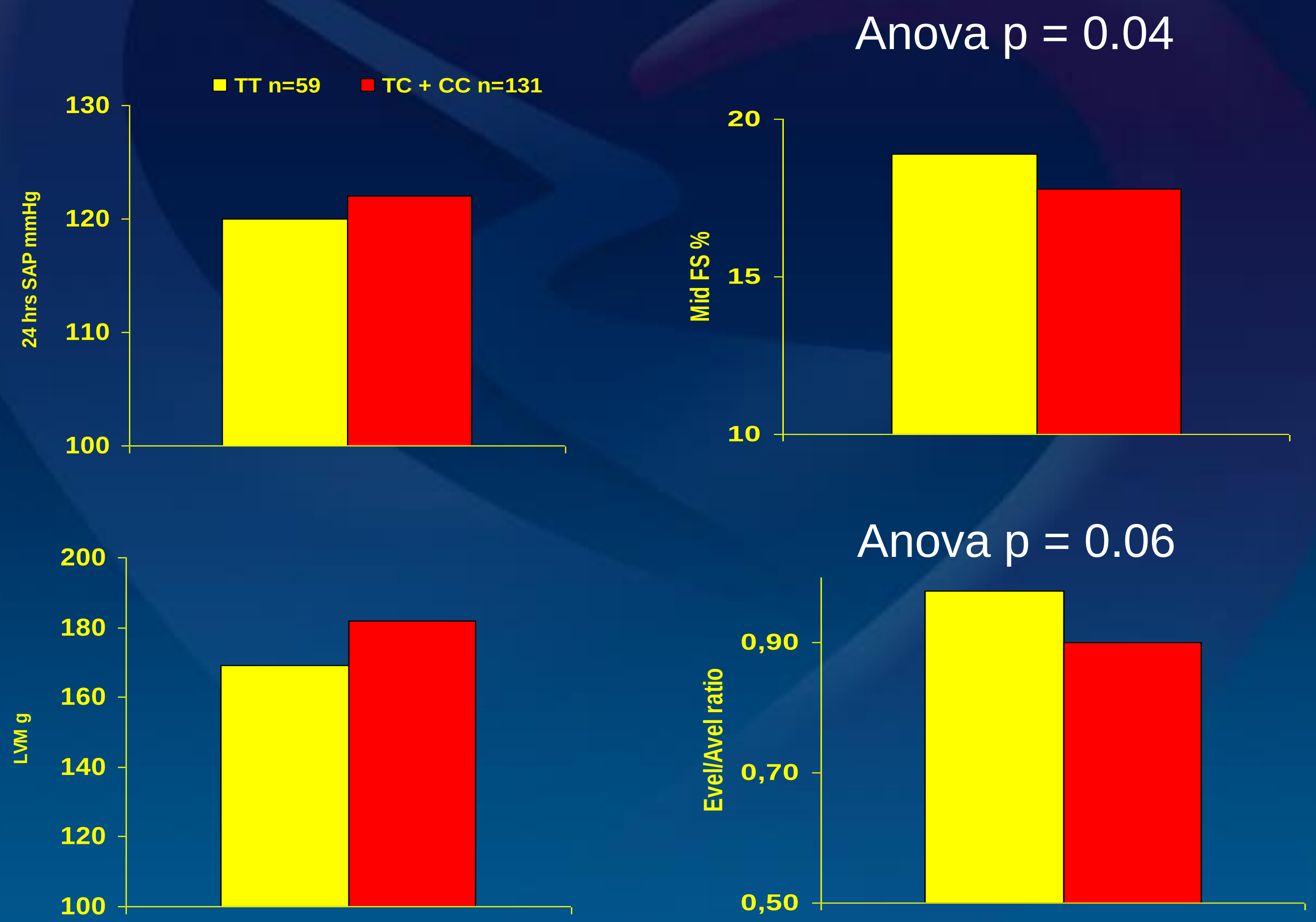
Doppler filling in young normotensive subjects with and without family history of hypertension



Muiesan et al, Clin Exper Hypertens 1996

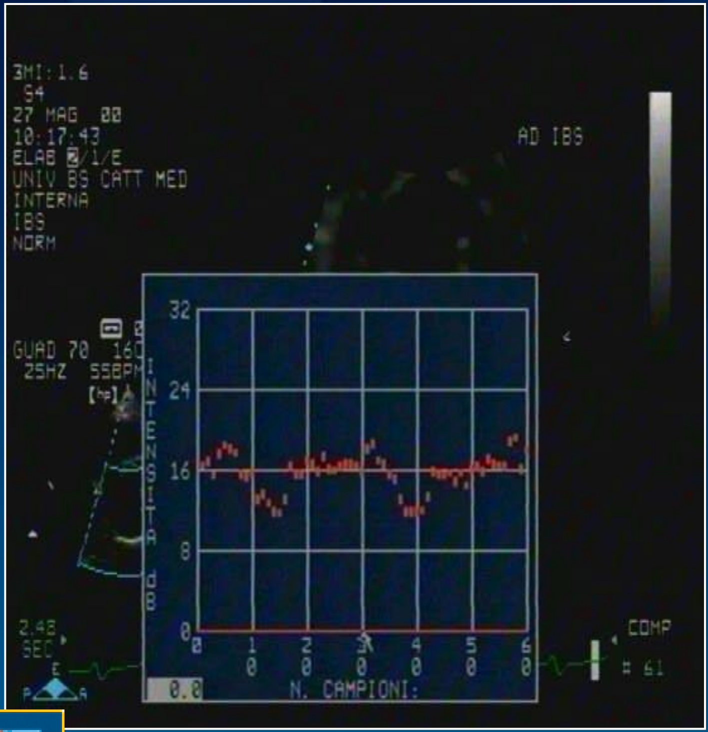
LV filling parameters and midwall systolic performance in a general population (Vobarno study) according to aldosterone synthase polymorphism

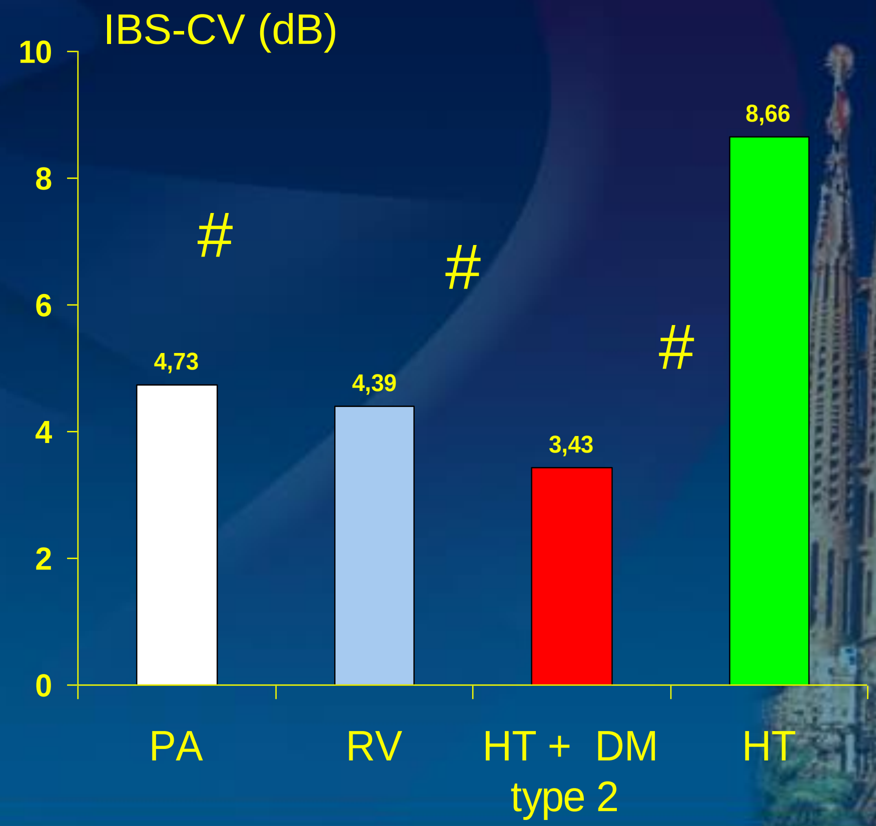


Cardiac tissue characterization in hypertensive heart disease

–Acoustic quantification of the backscatter signal, i.e. the ultrasound signals that originate from the myocardial tissue and back scatter towards the transducer

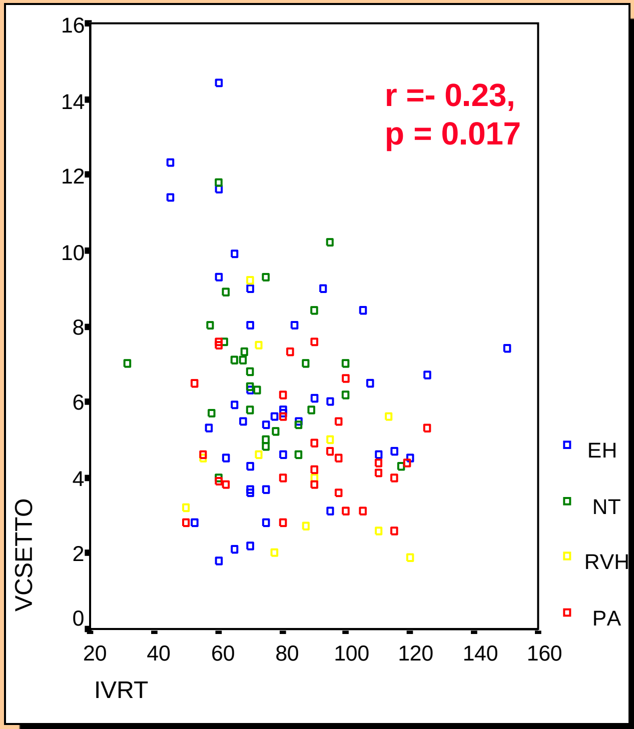
–The scattering power is related to the interaction between the ultrasound waves and the density and /or elasticity dys-homogeneity of the tissue



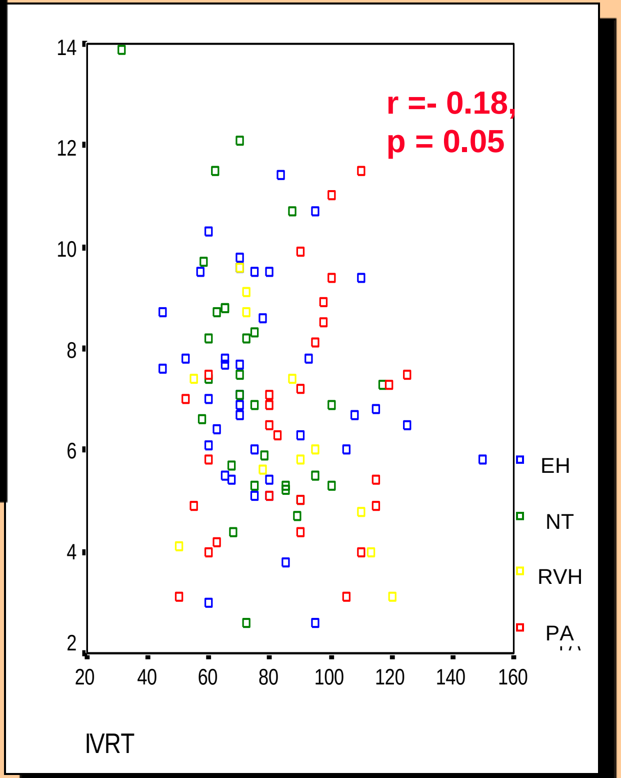


IBS CV and diastolic function

Cyclic variation of IBS signal (septum)



Cyclic variation of IBS signal (posterior wall)



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Prognostic significance of diastolic filling abnormalities

Aurigemma et al 2001

2671 men and women participating in to the Cardiovascular Health Study, mean follow up 5.2 yrs,

RR for incident CHF, adj for CV risk factors, 3.5 (95% CI,1.8-6.8) in patients with E/A > 1.5 and 1.88 (95% CI, 1.33-2.68) in patients with E/A < 0.7

Bella et al 2002

3008 American Indians (Strong Heart Study), mean follow up 3 yrs,

RR cardiac death with E/A > 1.5 = 2.8 (95% CI, 1.19-6.75, p<0.05)

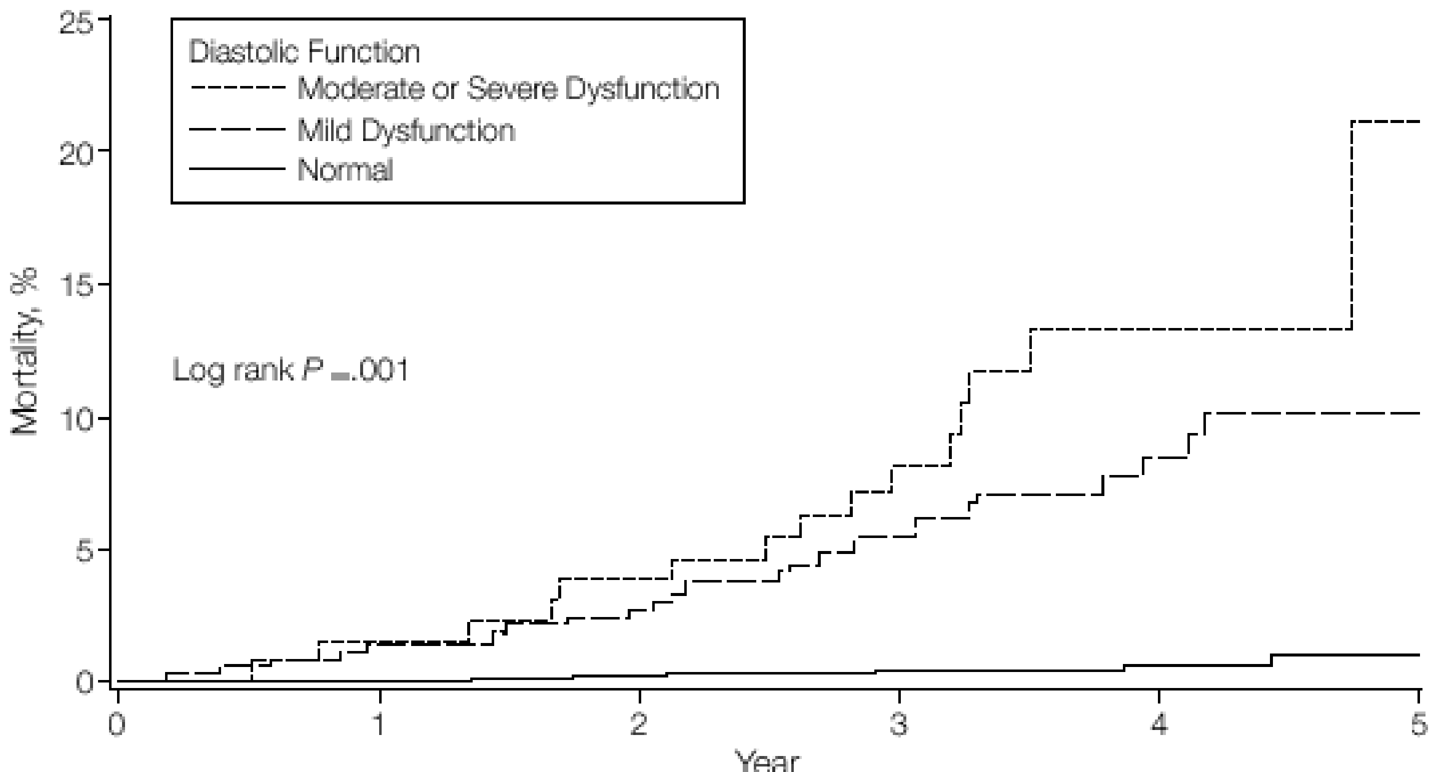
RR cardiac death with E/A < 0.6 = 1.18 (95% CI, 0.7-2.1, p=0.31)

Schillaci et al 2002

1839 Caucasian hypertensives (PIUMA Study), mean follow up 4.4 yrs,

OR adj for cardiovascular non fatal events 1.57 (95% CI,1.11-2.18,p<0.01) in patients with E/A < median value adjusted for age and heart rate

Kaplan Meier mortality curves for participants with normal diastolic function versus subjects with mild or moderate or severe diastolic dysfuntion



No. at Risk						
Normal	1277	1277	1275	885	404	38
Mild	371	366	361	246	122	8
Moderate or Severe	131	129	126	94	39	5

Redfield et al, JAMA 2003

Diastolic function for incident CV events

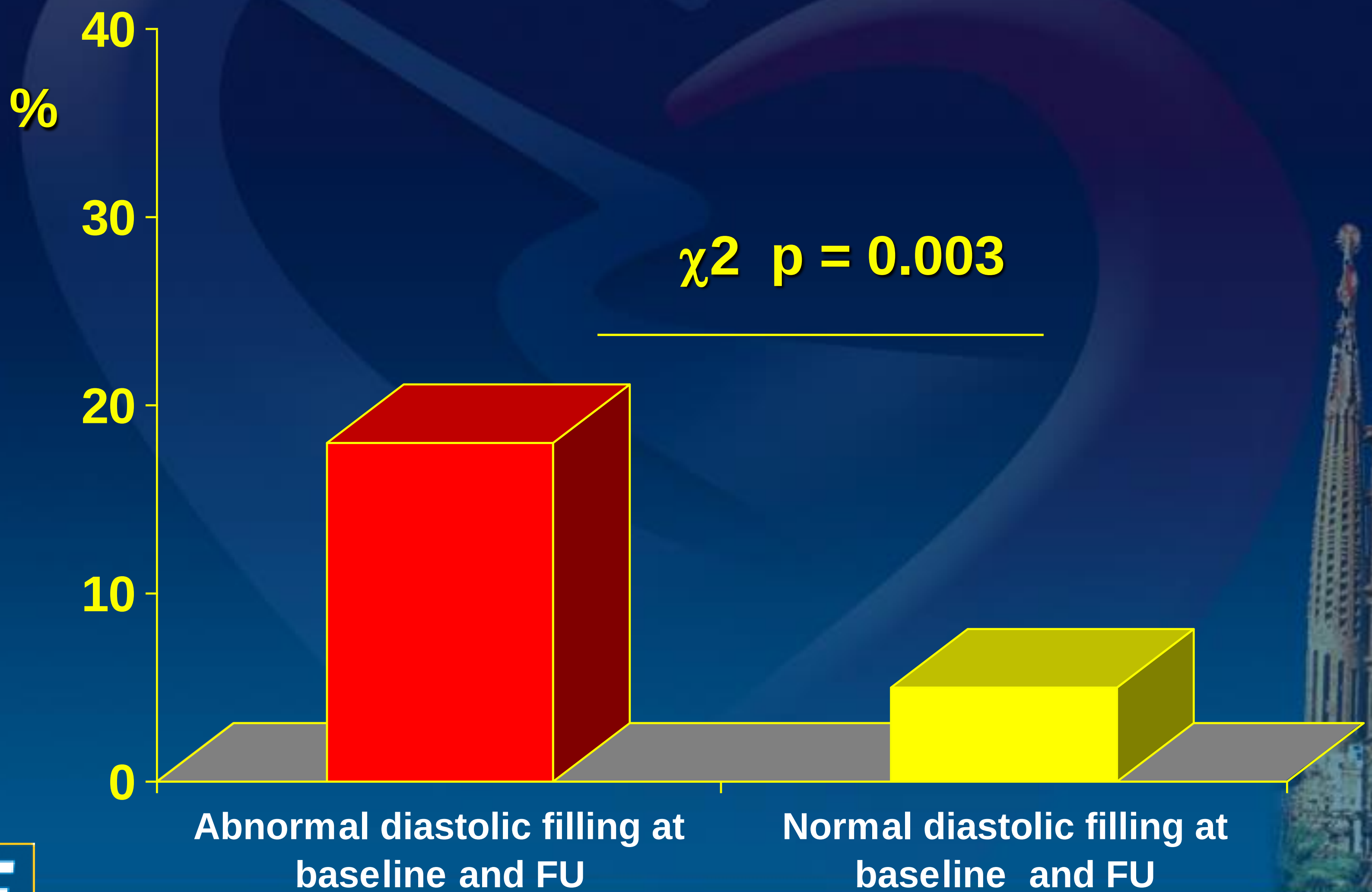
269 uncomplicated patients with essential hypertension

with acceptable M-mode and doppler echocardiophy, underwent the follow-up visit, according to a prospective design, after a mean period of 6 years (range 2-15 years).

159 M, 110 F; age range 18-71 years

	Age yrs	M/F	Follow-up yrs	PAS/PAD mmHg	HR b/min	LVMI $g/m^{2.7}$	Midwall FS %	E/A ratio
Normal diastolic filling n=204	**55 ± 6**	**114/90**	**4.3 ± 2**	**152 ± 14 95 ± 9**	**70 ± 12**	**48 ± 14**	**17.1± 3.3**	**0.96 ± 0.17**
Abnormal diastolic filling n=65	**58 ± 5**	**45/20**	**4.6 ± 2**	**157 ± 15 97 ± 9**	**73 ± 12**	**48 ± 14**	**16.7 ± 3.5**	**0.66 ± 0.20**

Non fatal CV events



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Normal exercise tolerance

Diastolic abnormalities

Reduced exercise tolerance

Diastolic dysfunction

Reduced exercise tolerance
and signs of CHF

Diastolic Heart Failure

Diastolic filling and exercise capacity (oxygen consumption at peak exercise)

Variable	Beta	T	*P*
Age (years)	−0.31	−2.90	0.060
Midwall shortening	0.16	1.55	0.129
Exercise change in isovolumic relaxation time (ms)	0.31	2.51	0.016
Peak heart rate (bpm)	0.24	2.44	0.018
Male gender	0.48	4.58	0.001
Resting E/A ratio	0.23	2.31	0.025

E/A, transmitral early/atrial filling velocity ratio.

Gerdts et al, Journal of Hypertension 2002; 20: 1223-1229

European Study Group on Diastolic Heart Failure

a) Signs or symptoms of CHF: exertional dyspnea and ↓ peak O_2 consumption

b) Normal or only mildly abnormal LV systolic function

c) Abnormal LV relaxation, filling, diastolic distensibility and diastolic stiffness

European Working Group Report *Eur Heart J, 1998*

Diastolic heart failure: 30% of all cases of congestive heart failure
Mortality 8% per year vs. 19% of systolic heart failure.

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ACC/AHA Guidelines for the evaluation and management of chronic heart failure in the adult

"…..In the absence of controlled clinical trials **the management of patients with diastolic dysfunction is based on the control of physiological factors** (blood pressure, heart rate, blood volume and myocardial ischemia)….."

Hunt et al. ACC/AHA Guidelines for the evaluation and management of chronic heart failure in the adult. JACC 2001; 38: 2101

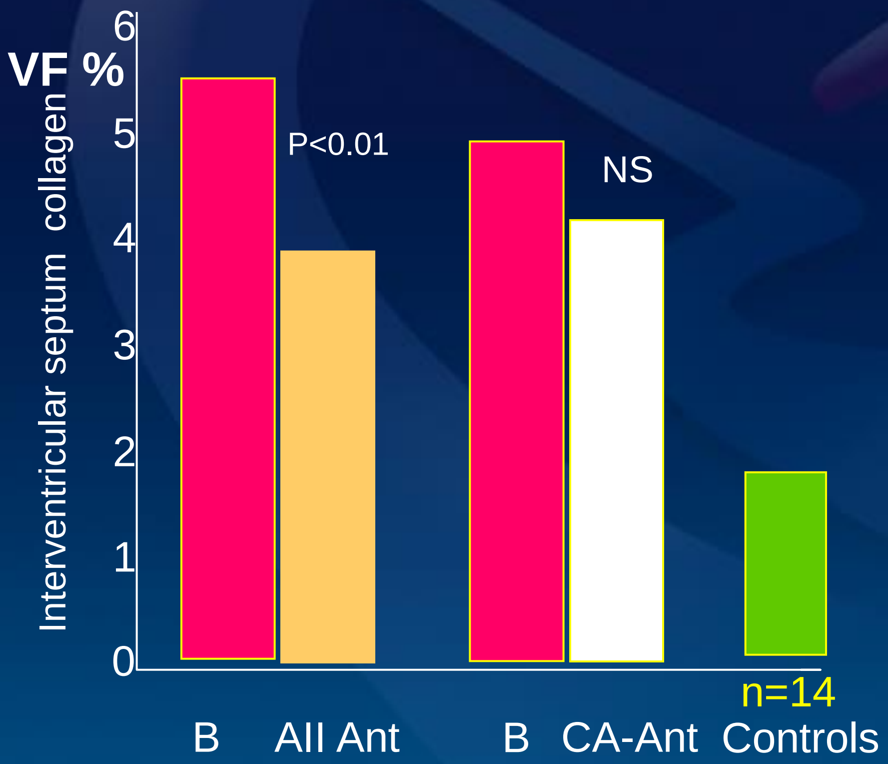
Change in Diastolic Left Ventricular Filling After One Year of Antihypertensive Treatment LIFE Study

	Total (n=726)		LV Mass Decrease (n=560)		No LV Mass Decrease (n=166)		Difference in Δ Between LV Mass Decrease or No Decrease
	Baseline	Year 1	Baseline	Year 1	Baseline	Year 1	*P*
Systolic blood pressure, mm Hg	174±20	151±19*	174±20	150±19*	174±22	153±21*	NS
Diastolic blood pressure, mm Hg	95±11	84±11*	95±12	84±11*	95±11	85±10*	NS
Body mass index, kg/m^2	27.4±4.5	27.5±4.6†	27.4±4.5	27.4±4.6	26.8±3.9	27.3±4.4*	<0.05
LV mass, g	234±56	207±51*	239±57	200±46⁻	214±51	233±57⁻	...
LV mass/body surface area, g/m^2	124±25	109±23*	126±25	105±21*	114±25	124±25*	...
LV mass/height$^{2.7}$, g/m$^{2.7}$	56.2±12.7	49.9±11.6*	57.4±12.9	48.0±10.5*	51.7±10.9	56.8±11.7*	...
LV internal diameter, cm	5.29±0.58	5.34±0.56*	5.31±0.57	5.29±0.56*	5.19±0.57	5.49±0.59*	<0.001
Interventricular septum, cm	1.16±0.15	1.04±0.14*	1.17±0.15	1.03±0.13*	1.11±0.15	1.10±0.17*	<0.001
Posterior wall thickness, cm	1.07±0.13	0.96±0.11*	1.08±0.13	0.96±0.11*	1.03±0.12	1.02±0.12*	<0.001
Relative wall thickness in end-diastole	0.41±0.067	0.37±0.054*	0.41±0.07	0.36±0.05*	0.40±0.06	0.38±0.06*	<0.001
Relative wall thickness in end-systole	0.93±0.19	0.85±0.16*	0.93±0.19	0.85±0.16*	0.91±0.18	0.83±0.17*	NS
Left atrial diameter, cm	3.93±0.02	3.81±0.02*	3.96±0.55	3.80±0.55*	3.85±0.59	3.86±0.60	<0.001
Isovolumic relaxation time, ms	115±25	105±22*	116±24	104±21*	115±25	110±24	<0.05
Mitral valve E/A-ratio	0.85±0.34	0.93±0.33*	0.83±0.29	0.92±0.32*	0.91±0.47	0.95±0.34	NS
Mitral valve deceleration time, ms	217±66	231±68*	216±63	231±68*	228±74	233±67	NS
Atrial filling fraction	0.42±0.10	0.38±0.11*	0.43±0.10	0.39±0.10*	0.42±0.10	0.38±0.09*	NS

**P*<0.001, †*P*<0.05 between year 1 and baseline value.

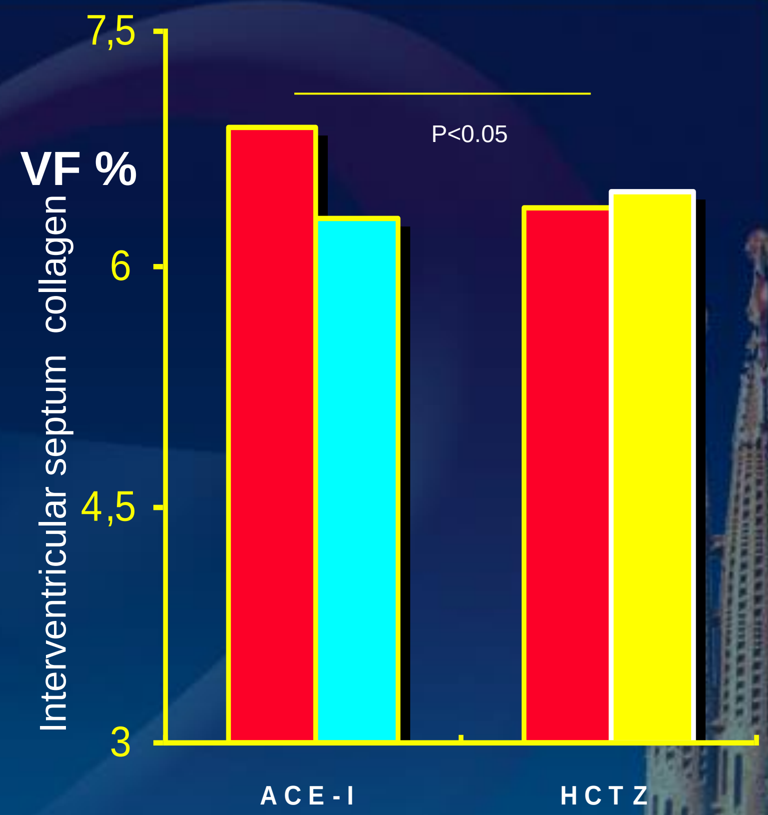
Circulation. 2002;105:1071-1076

Effects of antihypertensive treatment on myocardial fibrosis



Correlation between changes DET and CVF

r = 0.39, p < 0.05



IVRT **	IVRT
123 ± 9 to 81 ± 5 ms	117 ± 8 to 121 ± 9 ms

Lopez et al. - *Circulation 2001*

Brilla C et al. – *Circulation 2000*

Conclusions

In hypertensive patients abnormalities in both myocardial relaxation and passive filling may be detected.

Several techniques have been used for the assessment of LV diastolic function. Doppler echocardiography is one of the most widely used

Diastolic dysfunction may predict cardiovascular fatal and non fatal events, independently from other RF

Treatment of diastolic dysfunction should be aimed to control physiological factors, favouring the regression of LVH and possibly reducing fibrosis.