

Diastolic stress test

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Healthy, young, male; upright bicycle:

	Supine	Sitting, rest	Stage 1 HR 100	Stage 2 HR 120	Stage 3 HR 150	Stage 4 HR 184
HR	65	76	104	126	159	183
E (TVI cm/s)	93	74	107	108	144	152
E' (cm/s)	13	8	11	13	16	18
E/e'	7.4	9.2	9.5	8.5	8.8	8.3
EDV (ml)	165	140	144	146		
IVRT (ms)	71	73	46	41	33	38

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flow and tissue velocities, % increase

Time intervals

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Diastolic function in exercise:

- e' is load dependent
- E/e' does not reflect filling pressure in transition from supine to sitting
- Both E and e', but not E/e' increases with increasing exercise intensity
- LVEDV does not increase with moderate exercise

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Healthy elderly (71.7), both sexes

	Supine	Sitting	Submax
HR	69	72	128
E (cm/s)	60	50	118
e' (TVI cm/s)	7.3	4.1	12.9
E/e'	8.2	12.2	9.1

Moelmen et al (unpublished)

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Conclusion 1:

- Healthy subjects does not seem to use Frank-Starling mechanism in light exercise, even at age 70+

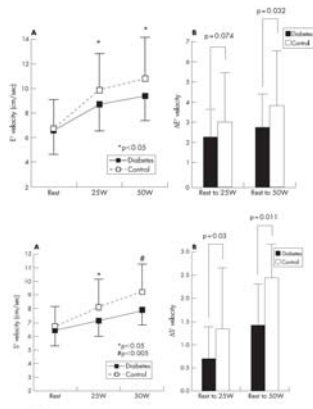
Patients: Burgess 2006:

- 36 pats with HF
- Supine bicycle
- Invasive validation
- Stress HR~85;
 - no E/A fusion (?)
 - Group 1: LVEDP N
 - Group 2: LVEDP↑ at exercise
 - Group 3: LVEDP↑ at rest

	Group 1	Group 2	Group 3
HR _{rest}	61	69	62
HR _{stress}	82	87	81
E _{rest} (cm/s)	76	80	100
E _{stress} (cm/s)	84	90	105
e' _{rest} (cm/s)	8.0	7.3	6.5
e' _{stress} (cm/s)	8.3	6.1	6.5
E/e' _{rest}	9.8	11.8	16.3
E/e' _{stress}	10.3	16.1	18.1
LVEDP _{rest}	8.3	8.9	20.8
LVEDP _{stress}	9.1	21.5	20.4

Patients:

- Ha 2007: Supine bicycle
- Diabetes vs controls
- Lower S' and e' at exercise already at 25W supine, despite no difference at supine rest.
- Ha 2009: Ed=E/e'/SV
- Higher in abnormal relaxation
- Quantitative rather than Qualitative difference



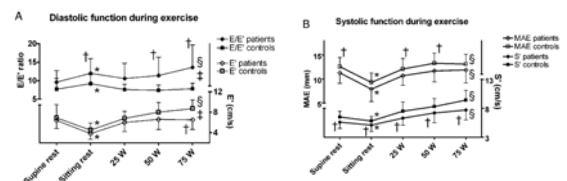
Rustad et al 2009:

- 18 patients with previous MI, all on β-blockers
 - Mean age 59 years, 14♂, 4♀
 - Mean EF 46%
- 18 sex and age matched healthy controls
- Examined supine, sitting upright at bicycle rest
- Upright bicycle exercise 25W, 50W 75W
- No evident ischemia (wall motion abnormalities) at exercise

Infarct vs controls, both sexes

		Supine	Upright	25W	50W	75W
HR	Contr	58	64	73	85	98
	Pats	59	66	75	86	99
E (cm/s)	Contr	49	39	50	57	66
	Pats	58	43	59	68	79
e' (TVI cm/s)	Contr	6.8	4.4	6.8	8.0	8.7
	Pats	6.4	3.6	6.0	6.6	6.5
E/e'	Contr	8.0	9.9	7.6	7.4	7.8
	Pats	9.4	12.7	10.6	11.4	13.6
EDV (ml)	Contr	138	106	129	127	125
	Pats	130	103	126	131	124
IVRT (ms)	Contr	105		75		54
	Pats	118		83		60

Diastolic versus systolic function



Rustad 2009

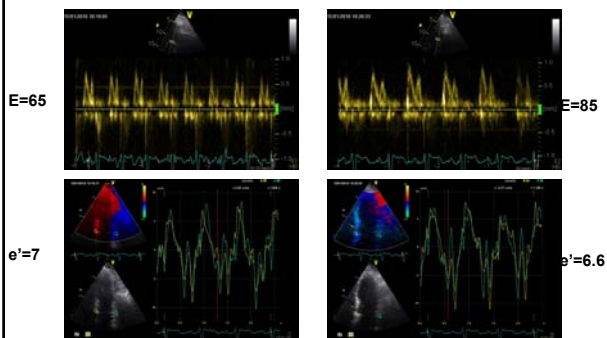
Conclusions 2:

- **Pathological response:**
 - Increase in filling (E – pseudonormalisation)
 - No increase in e'
 - Increased filling confirmed by increased EDV
- **Best measures: e' , E/ e' , EDV**
- **Pseudonormalisation in IVRT**
- **Pseudonormalisation in systolic function**
 - Via Frank-Starling mechanism
- **Diastolic abnormalities evident in moderate pathology that seem normal at rest.**



From 50W

to 75W



Even with limited pathology

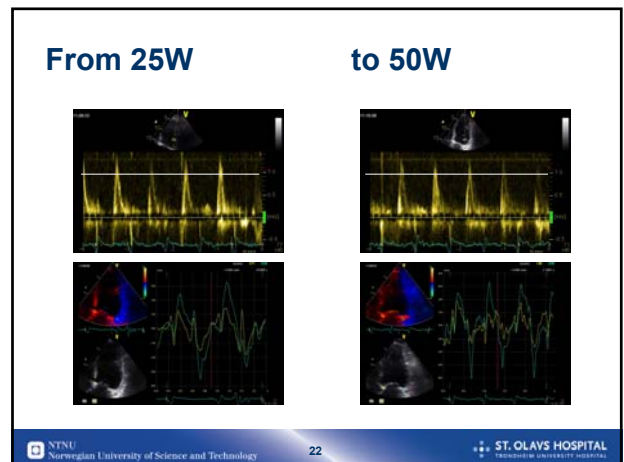
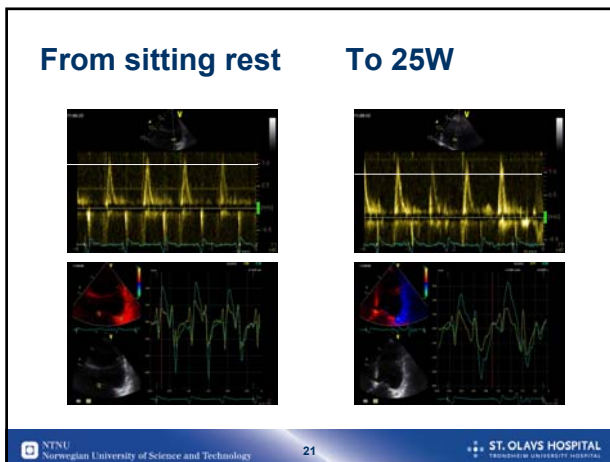
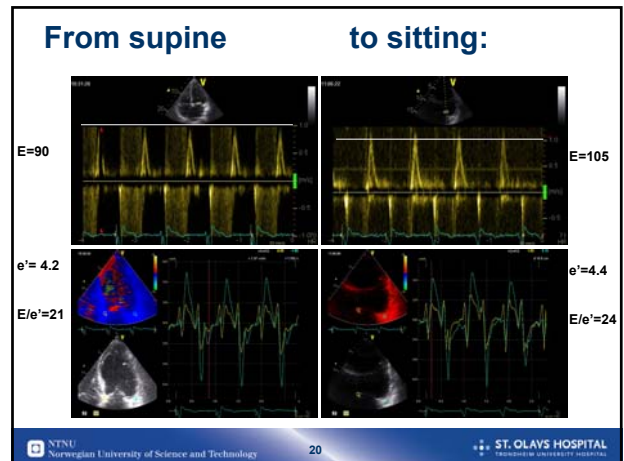
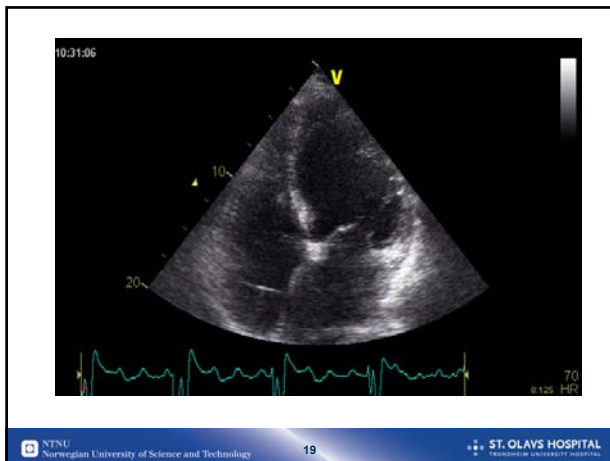
- The myocardial changes needs to be fairly extensive, although moderate.

Which patients?



So what?

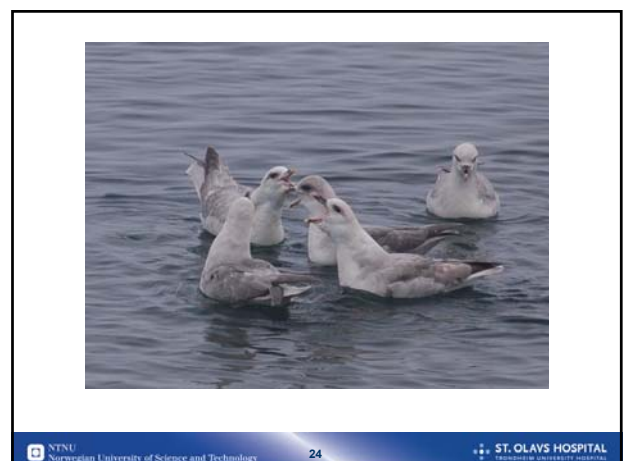
- Which cases can this diastolic abnormalities be demonstrated?
 - Diabetes? (Cf Ha 2007)
 - Hypertension?
 - Metabolic syndrome?
 - Obesity
- What about E/A fusion?
- What about atrial fibrillation?
- Supine or upright?
- What will be the clinical consequences?
- Can diastolic response be improved by exercise training?



Which modality?

- **Sitting?**
 - Lack of pressure drop unmasked?
 - Clinical implications?
 - Degree of HF?
 - Prognosis?
- **Supine?**
 - Easier, better image quality

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Thank you for your attention

