

Aortastenose

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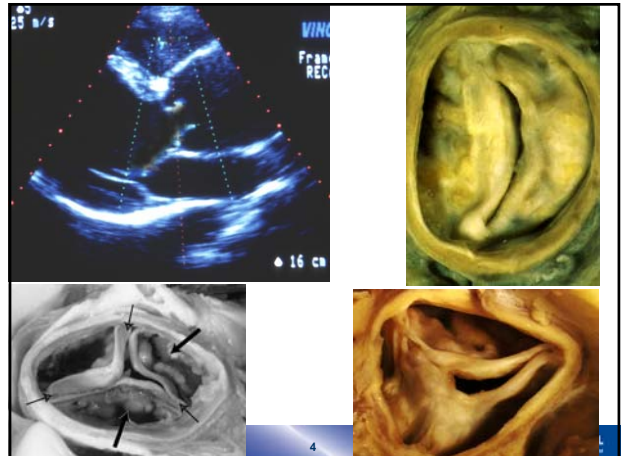
Anamnese:

Early valve replacement should be strongly recommended in all symptomatic patients with severe AS who are otherwise candidates for surgery.

ESC guidelines; EHJ 28 (2007) 230 - 268

Aortastenose - utredning

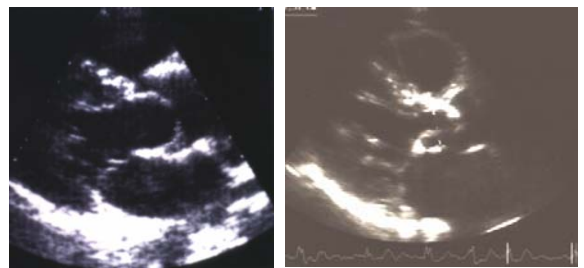
- Aortarot og LVOT
- Klaffemorfologi
- Ve. ventrikel, hypertrofi og funksjon
- Funksjon av andre klaffer
- Aortaklaffefunksjon
 - Gradient
 - Klaffeareal
 - Dobutamintest ved ve. ventrikkelsvikt
 - Frekvenskorrigert ejsjonstid for venstre ventrikel
 - Valvulær resistens
 - Energitap (stroke work loss)



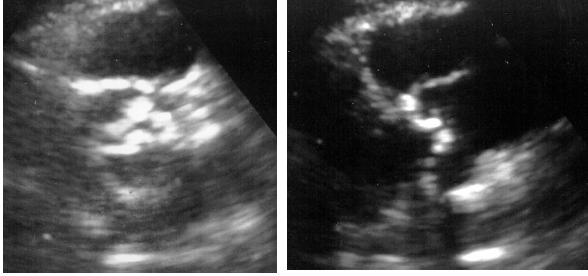
Klaffe- og LVOT morfologi



Klaffe- og LVOT morfologi



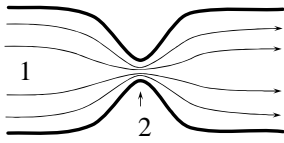
Klaffemorfologi - 2. harmonisk avbildning



Kvantitering av aortastenose

- Gradient
- Areal ved kontinuitetslikningen
- Areal ved øsofagusekko
- Endringer i areal og gradient under stress
- Areal ved transthorakal ekkokardiografi?

Gradientmålinger

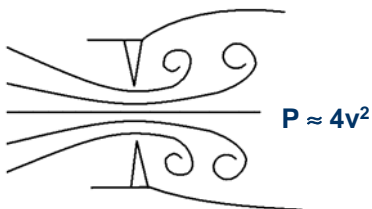


$$P = 4v^2$$

Normal uttrekkskurve VV - Ao:



Aortastenose med turbulent flow:

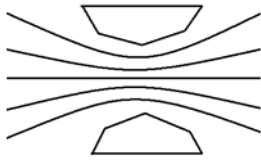


Hastighetsøkning gjennom stenosen (samme volum gjennom mindre areal):
 ⇒ Trykkenergi konverteres til kinetisk energi: $P \approx 4v^2$
 Laminær flow brytes opp til turbulent flow og energien går tapt
 ⇒ Trykkfallet er konstant

Dette gir følgende uttrekkskurve:



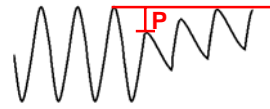
Aortastenose med laminær flow:



$$P \approx 4v^2$$

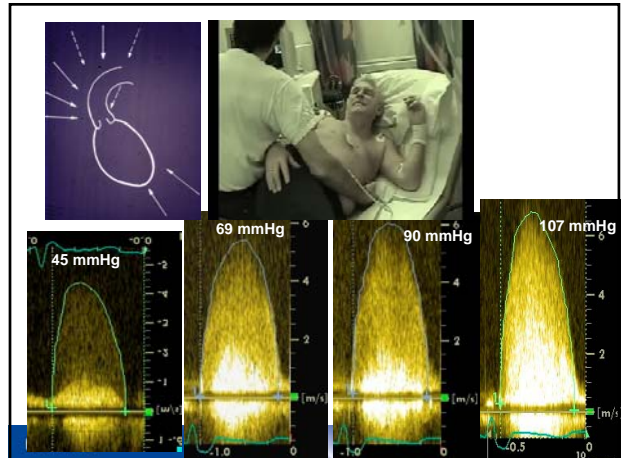
Hastighetsøkning gjennom stenosen (samme volum gjennom mindre areal):
 ⇒ Trykkenergi konverteres til kinetisk energi: $P \approx 4v^2$
 Laminær flow fortsetter etter stenosen, og hastigheten avtar
 ⇒ Trykkenergien gjenvinnes

Dette gir følgende uttrekkskurve:

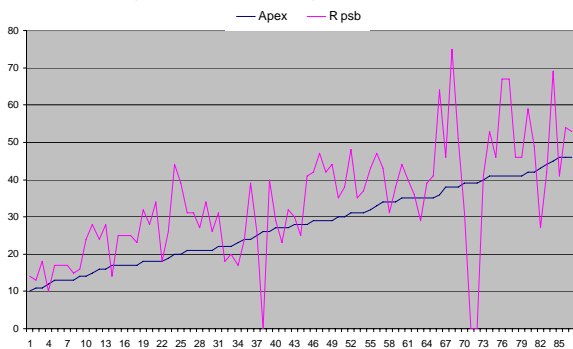


Liten trykkgjenvinning ved:

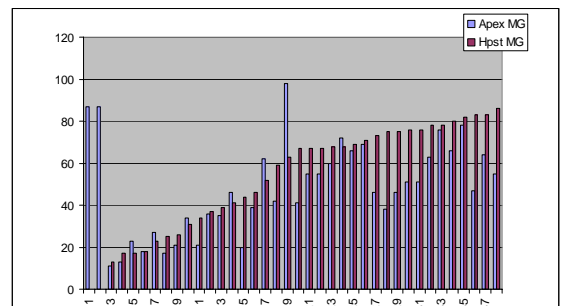
- Skarp stenose
- Bet forkalkning
- Vid aorta etter stenosen



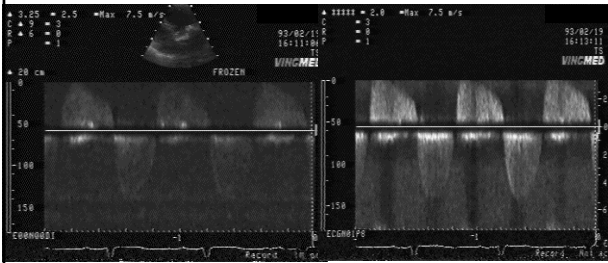
Mean gradients, Apex - Right parasternal border



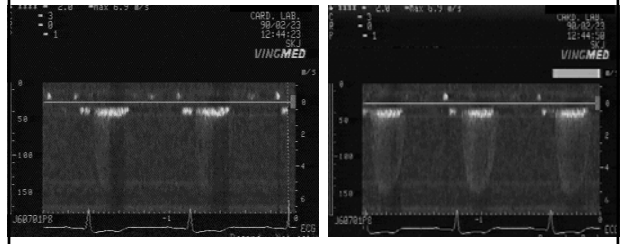
Gradienter Apex – høyre parasternalrand



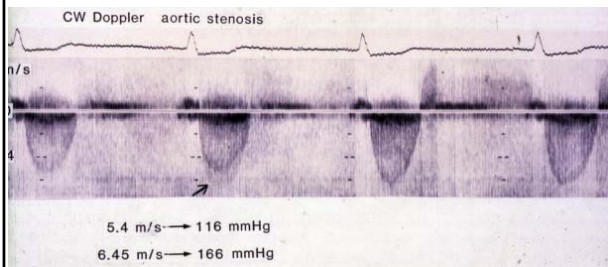
Aortastenose Duplex versus stand alone Doppler probe



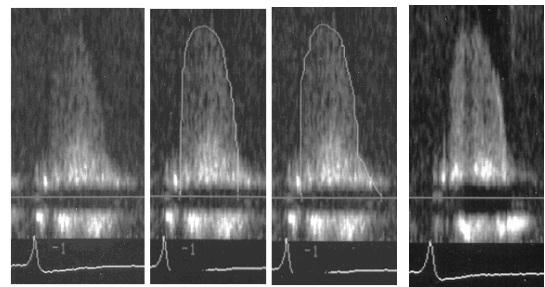
Aorta jet hastigheter. Effekt av høypass filter.



Optimalisering av signalet

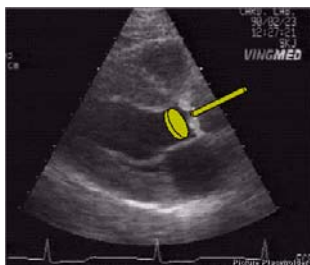


Tracing av hastighetskurve



Middelgradient: 31 mmHg 22 mmHg

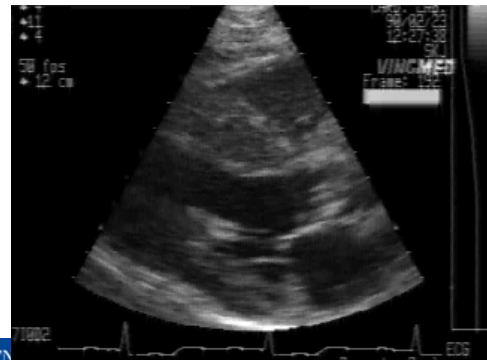
Klaffeareal - kontinuitetslikninga



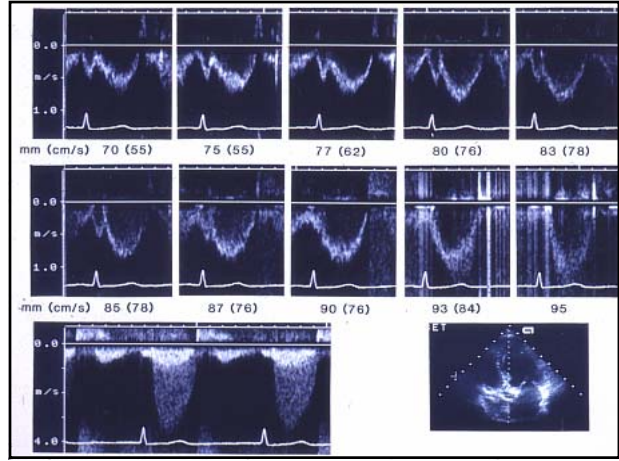
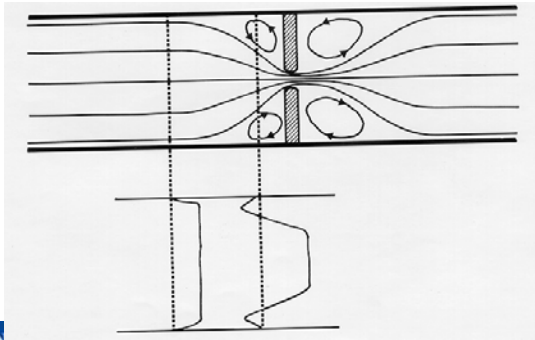
$$\text{Sten. areal} \times \text{Sten. hastighet} = \text{LVOT areal} \times \text{LVOT hastighet}$$

$$\text{Stenoseareal} = \frac{\text{LVOT areal} \times \text{LVOT hastighet}}{\text{Stenosehastighet}}$$

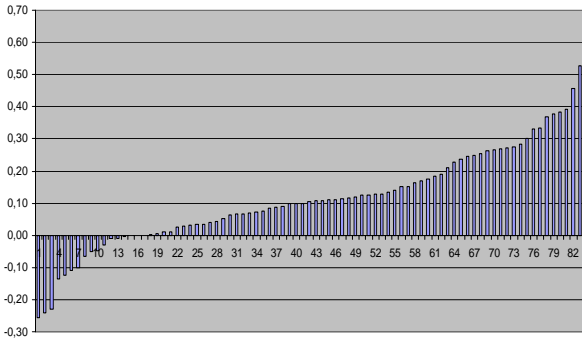
Subvalvulær diameter



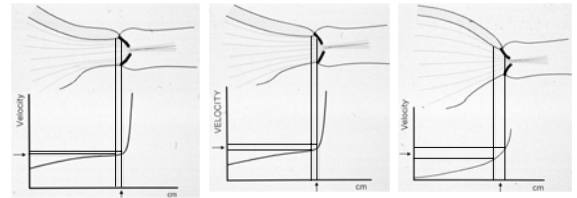
Prestenotiske hastigheter



Aortic valve area difference, Apex - Right parasternal border



LVOT anatomy and subvalvular velocity patterns



Operasjonsindikasjoner

Table 7 Indications for aortic valve replacement in aortic stenosis

| | Class | |
|--|-------|-----|
| Asymptomatic patients with severe AS and moderate-to-severe valve calcification, and a rate of peak velocity progression ≥ 0.3 m/s per year | IaC | IaC |
| Patients with severe AS and any symptoms | IB | IaC |
| Patients with severe AS undergoing coronary artery bypass surgery, surgery of the ascending aorta, or on another valve | IC | IbC |
| Asymptomatic patients with severe AS and systolic LV dysfunction (LVEF < 50%) unless due to other cause | IC | IbC |
| Asymptomatic patients with severe AS and abnormal exercise test showing symptoms on exercise | IC | IbC |
| Asymptomatic patients with severe AS and abnormal exercise test showing fall in blood pressure below baseline | IaC | IbC |
| Patients with moderate AS* undergoing coronary artery bypass surgery, surgery of the ascending aorta or another valve | IaC | IbC |

AS = aortic stenosis, EF = ejection fraction, LV = left ventricular.
 *Moderate AS is defined as valve area $1.0-1.5 \text{ cm}^2$ ($0.8 \text{ cm}^2/\text{m}^2$ to $0.9 \text{ cm}^2/\text{m}^2$ BSA) or mean aortic gradient 30-50 mmHg in the presence of normal flow conditions. However, clinical judgement is required.

Operasjonsindikasjoner:

Surgery should only be considered in asymptomatic patients with severe AS. According to the ACC/AHA guidelines^[1] reduction in valve area to $< 1.0 \text{ cm}^2$ has been considered as severe AS. However, it is advised to adjust the valve area to the body surface area (BSA), the threshold for severity being $< 0.6 \text{ cm} \cdot \text{m}^{-2} \text{ BSA}^{[4-5]}$. (I)

ESC 2002

Operasjonsindikasjoner:

Even if the benefit is not definitely proven, surgery is recommended in the following circumstances:

(IIa)

1. patients with an abnormal response to exercise: development of symptoms, blood pressure fall, inadequate blood pressure rise, markedly impaired exercise tolerance (Table 2).
2. patients with moderate to severe calcification, a peak jet velocity $>4 \text{ m} \cdot \text{s}^{-1}$, and with an accelerated rate of progression of peak velocity ($\geq 0.3 \text{ m} \cdot \text{s}^{-1}$ per year) because of their fast progression towards symptoms;
3. patients with left ventricular dysfunction (left ventricular ejection fraction $<50\%$). This situation is however rare in asymptomatic AS.

ESC 2002

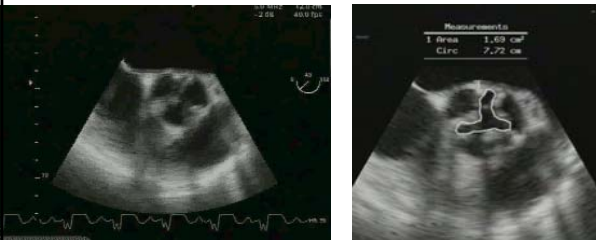
Operasjonsindikasjoner:

Even if there is a lower level of evidence, surgery can probably also be considered in the following situations: **(IIb)**

- Severe left ventricular hypertrophy ($>15 \text{ mm}$ wall thickness) unless this is due to hypertension;
- Severe ventricular arrhythmias for which no other cause than severe AS can be identified.

ESC 2002

klaffeareal, øsofagusekko



Problemet lite areal, lav gradient og redusert ve. Ventrikkelfunksjon:

- Lavt SV gir lav gradient
- Lavt SV gir lite areal (med alle metoder)
 - = funksjonell stenose
- → Lavdose dobutamin stressekko
 - Gradientendring
 - Arealendring
 - kontraktil reserve
- Korrigert ejsjonstid for ve. ventrikkel
- Grad av klaffekalk

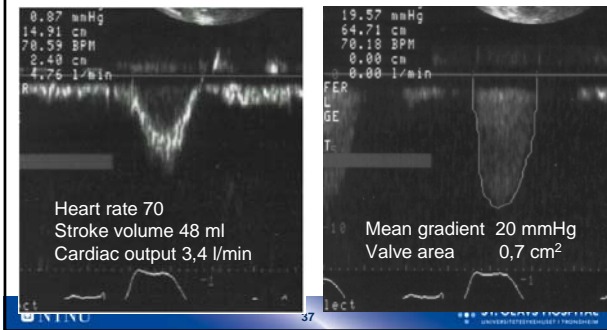
As long as mean gradient is still $>40 \text{ mmHg}$, there is virtually no lower EF limit for surgery.

ESC guidelines; EHJ 28 (2007) 230 - 268

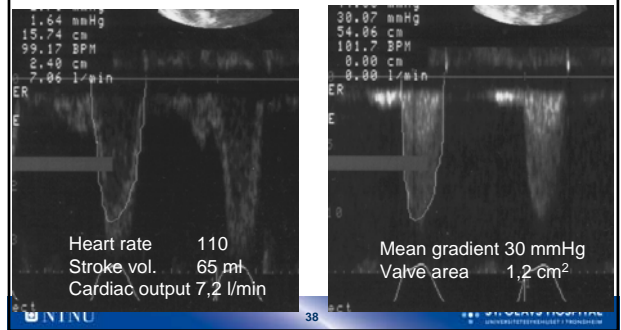
Lavdose dobutamin stressekko

- Alvorlig stenose (fiksert stenose)
 - Arealøkning $<0,3 \text{ cm}^2$
 - Sluttareal mindre enn $1,0 \text{ cm}^2$
- Kontraktil reserve (prognose):
 - SV økning $>20\%$
 - og/eller betydelig økning av EF.

Stress test Måling før Dobutamin

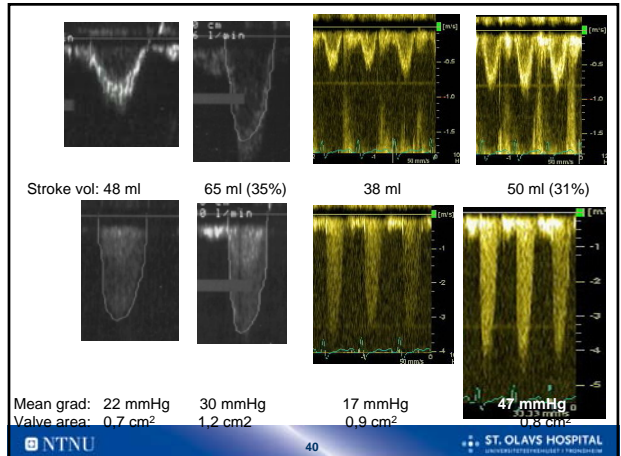


Måling under Dobutamin infusjon 20 ug/kg/min



Fiksert aortastenose under stress

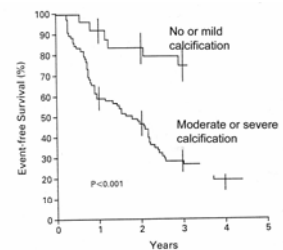
| Dose Ug/kg/min | Before stress | 24 ml/h 5 | | | 48 ml/h 10 | | | 96 ml/h 20 | | |
|-----------------------|---------------|-----------|-----|-----|------------|-----|-----|------------|-----|------|
| Minuts | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Heart rate | 106 | 102 | 104 | 107 | 110 | 117 | 121 | 122 | 130 | 138 |
| Blood press. | 115 | 113 | 123 | 115 | 121 | 116 | 114 | 110 | 102 | 90 |
| Angina | - | - | - | - | - | - | - | - | - | - |
| Str. vol. ml | 68 | | | | | | | | | 56 |
| CO l/min | 7,2 | | | | | | | | | 7,7 |
| Mean grad. | 36 | | | | | | | | | 51 |
| AVA1, cm ² | 0,54 | | | | | | | | | 0,54 |



Frekvenskorrigeret ejsjonstid (LVETc)

- Frekvenskorreksjon av LVET:
 - Menn:
 - $LVETc = LVET + 1,7 \times HR$ (normalt: 418 (398-438))
 - Kvinner:
 - $LVETc = LVET + 1,6 \times HR$ (normalt: 413 (393-433))
- Normal eller forlenget LVETc ved aortastenose og samtidig redusert ve. ventrikkelfunksjon er en sterk indikasjon på uttalt aortastenose

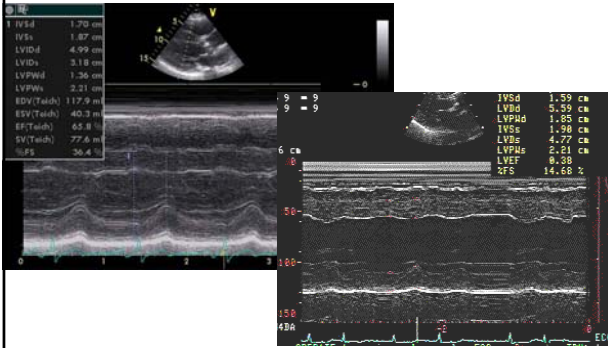
Klaffekalk og prognose



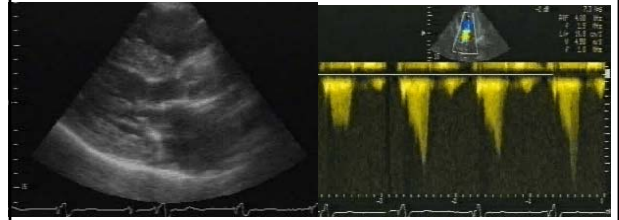
| No. of Patients at Risk | 25 | 23 | 20 | 17 | 9 |
|----------------------------------|-----|----|----|----|---|
| No or mild calcification | 25 | 23 | 20 | 17 | 9 |
| Moderate or severe calcification | 101 | 48 | 38 | 21 | 7 |

Rosenhek et al. N. Engl J Med 2000

Venstre ventrikkelfunksjon og hypertrofi



Subvalvulær dynamisk stenose



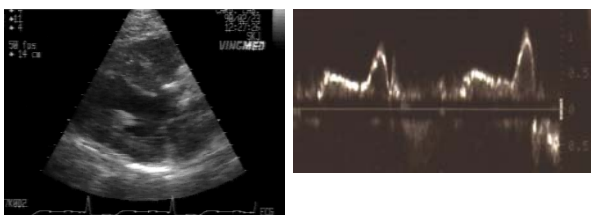
Subvalvulær, dynamisk stenose



Hypertrofi

- Hvis hypertrof ventrikkel uten annen forklaring, må stenosen regnes som signifikant til det motsatte er bevist.

VV diastolisk funksjon



Økt fyllingstrykk

