

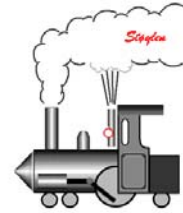
Vevsdoppler ekkokardiografi og speckle tracking:

Asbjørn Støylen, Dr. Med.
 Institutt for sirkulasjon og bildediagnostikk,

DMF,
 NTNU

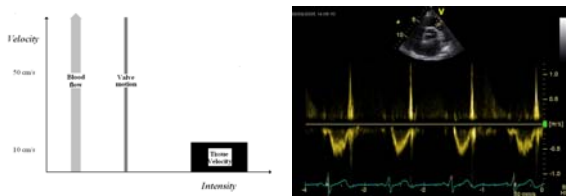
www.ntnu.no/~stoylen/lectures
www.ntnu.no/~stoylen/strainrate

Samme prinsipp som Doppler flow:



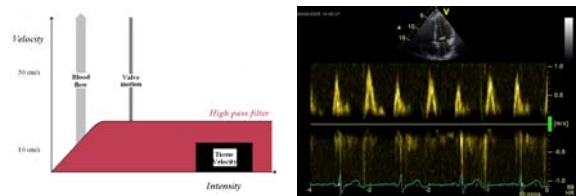
$$f - f_0 \approx 2 f_0 \frac{v}{c} \cos(\alpha)$$

Vevsdoppler

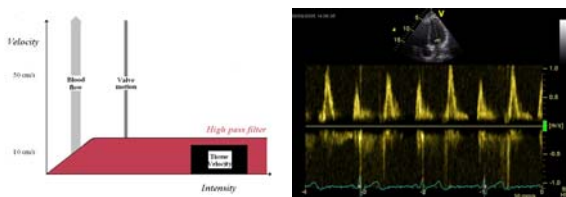


Prinsipielt som Doppler flow:
 Blod: Høye hastigheter, lav intensitet (Høypassfilter)
 Vev: Lave hastigheter, høy intensitet

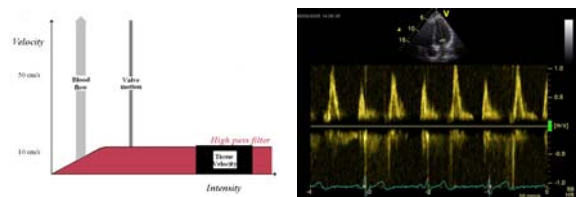
Høypassfiltrering



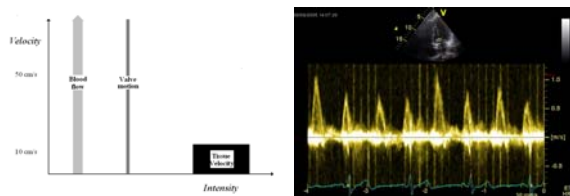
Høypassfiltrering



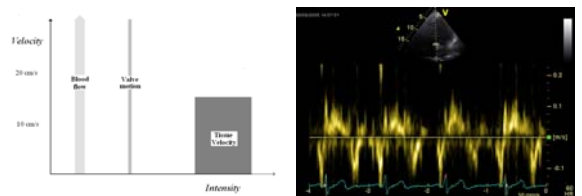
Høypassfiltrering



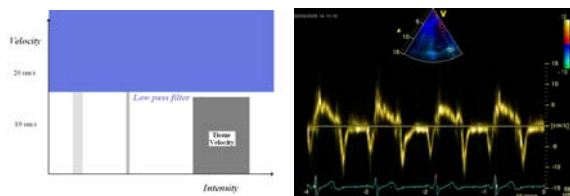
Ingen filtrering



Ingen filtrering, lav gain



Lavpass filtrering



Vevsdoppler:

- Beskrevet teoretisk 1976 (Angelsen)
- Pulset vevsdoppler 1989 (Isaaz)
- Farge vevsdoppler 1992 (McDicken)

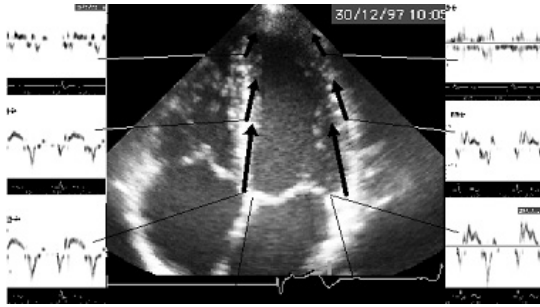
Vevsdoppler:

- Pulset (Global funksjon)
 - Sekvensiell
 - Robust
 - Online (rask)
- Farge
 - Simultan (regional funksjon)
 - Sensitiv for støy
 - Postprosessering

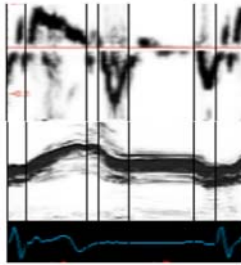
Langaksebevegelsen:



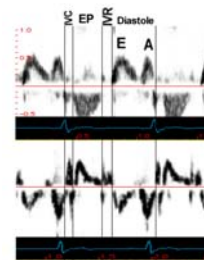
Vevsdoppler:



Pulset vevsdoppler



Vevsdoppler og flow:



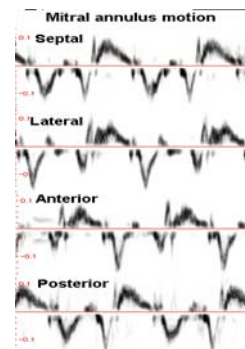
- Flow: Resultat av trykkforskjeller

- Kontraksjon: Årsak til trykkforskjeller

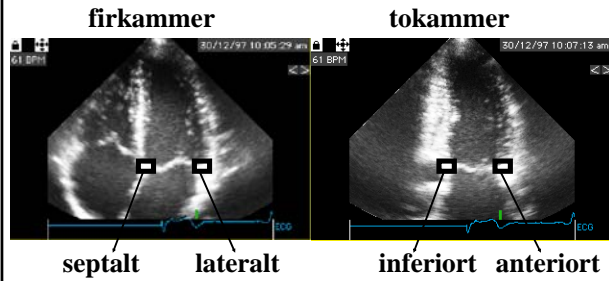
Normalverdier systolisk hastighet:

- Gulati et al 1996:
 - Peak velocity korelerer med EF: $R = 0.86$ (Støylen et al 2003: $R = 0.66$)
 - Peak velocity $> 5,4$ cm/s tilsvarer EF $> 50\%$
- Vinereanu et al 2001:
 - Peak velocity > 9 differensierer mellom normal og patologisk hypertrofi (men alle med normal EF)
 - Normalverdi > 8

Posisjonsavhengighet :

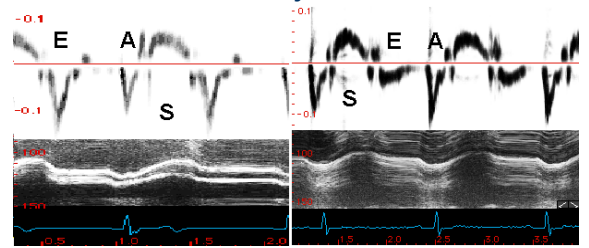


Normalverdiene gjelder gjennomsnitt av 4 punkter:



Gjennomsnittet av 4 punkter reduserer også variabiliteten med 25%

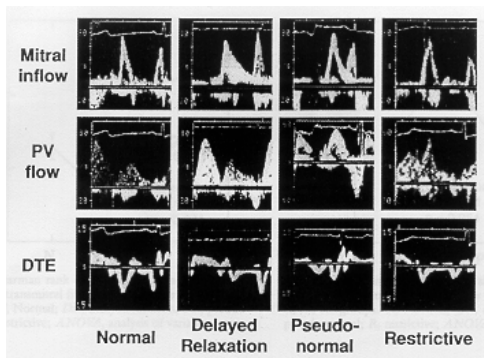
Diastolisk funksjon VV:



Frisk person

Hypertensiv pasient med forsinket relaksasjon

Diastolisk funksjon:



Normalverdier for e-hast.i mitralannulus, forenklet

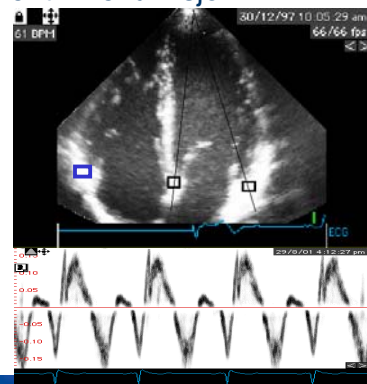
- Yngre voksne:
 - >10 cm/s
- Eldre voksne
 - >8 cm/s

E/A ratio i mitralflow vs Ea/Aa ratio til mitralannulus

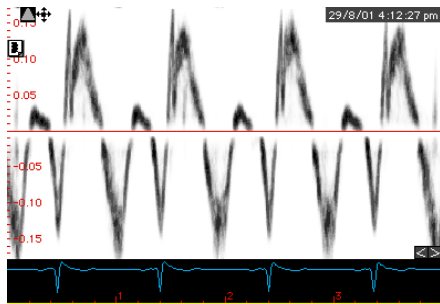
	Normale n=34	Forsinka relaksasjon n=40	Pseudonormale n=51
E/A	1,4±0,3	0,66±0,14	1,7±0,5
Ea/Aa	1,4±0,4	0,62±0,2	0,66±0,2
E/Ea	7,7±3	7,8±3,5	18±4

Nagueh 1997

Høyre ventrikkelfunksjon:



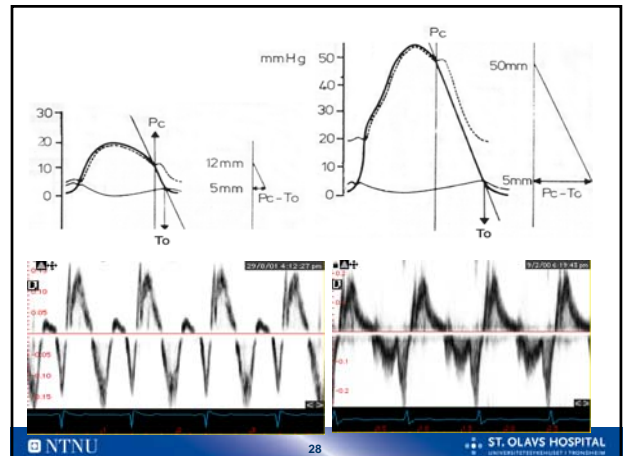
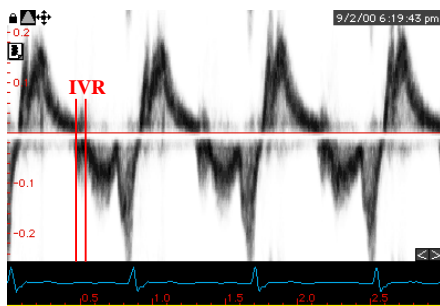
Høyre ventrikkelfunksjon:



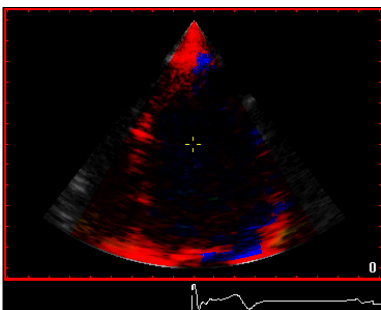
Høyre ventrikkelfunksjon

- Peak systolisk hastighet av tricuspidalringen
- Et målepunkt.
- Normalt 15 cm/s = Normal høyre ventrikkelfunksjon patologisk < 10 cm/s (Alam 2000)
- Hø. Atrietrykk: E/Ea korrelerer dårligere med fyln. Trykk (Nageh 1999) (dessuten finnes bedre metoder som
 - Venestuvning
 - Vena cava)
- Systolisk pulmonalarterietrykk?
 - Påvisbar IVR (cfr Burstin 1967)

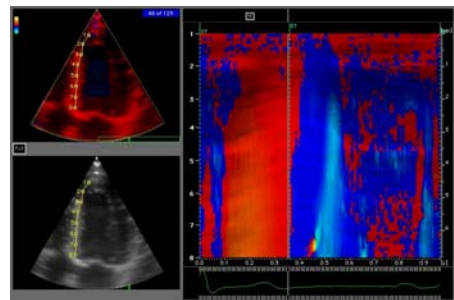
RV IVR med vevsdoppler:



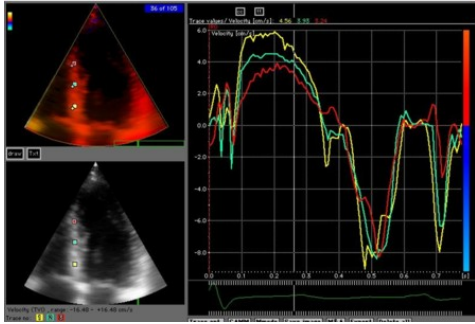
Farge vevsdoppler:



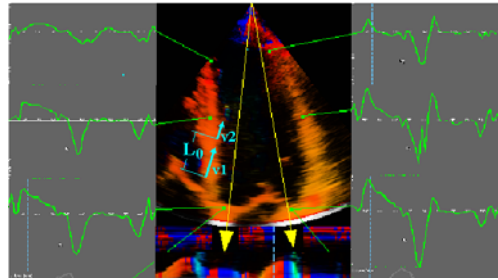
Curved M-mode (CMM):



Kvantitative kurver

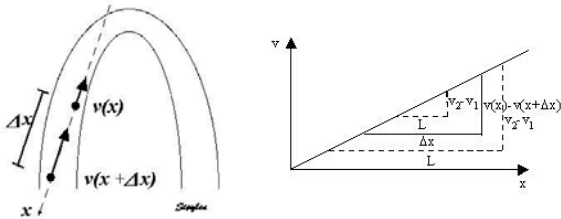


Strain rate:



$$SR = v_1 - v_2 / L_0$$

Strain rate:

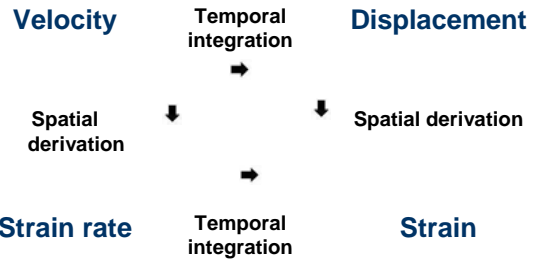


Heimdal, stoylen et al 1998

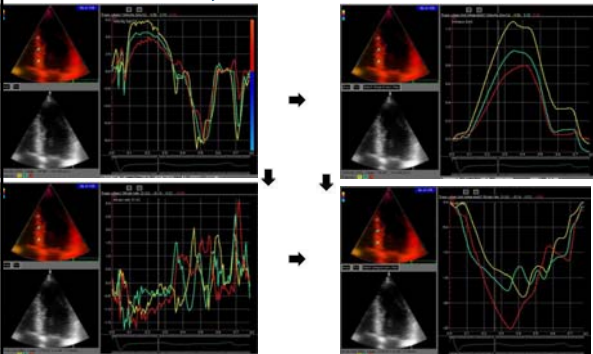
Fleming et al 1994

$$SR = \frac{v(x) - v(x + \Delta x)}{\Delta x} = \frac{\Delta v}{\Delta x} = \frac{v_1 - v_2}{r} = VG$$

One dataset, four modalities:



One dataset, four modalities:



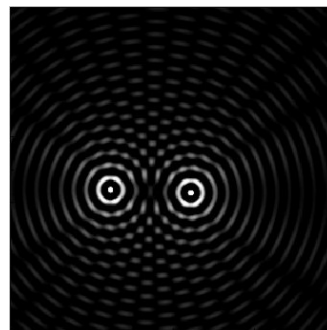
Speckle tracking



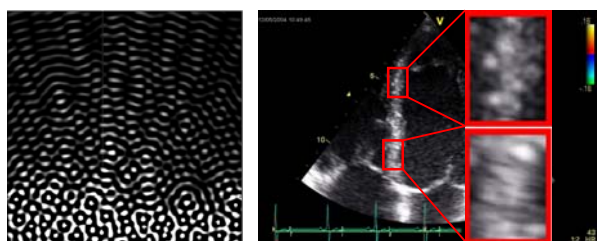
What is speckle tracking?



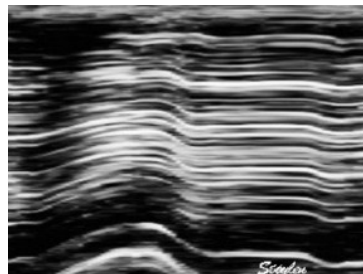
Interference



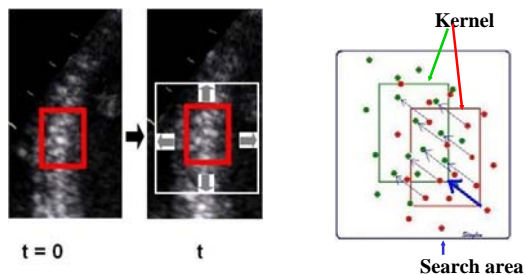
1: Speckle pattern is random; each kernel has a unique "fingerprint"



2: Speckle pattern is fairly constant and follows the myocardial motion.



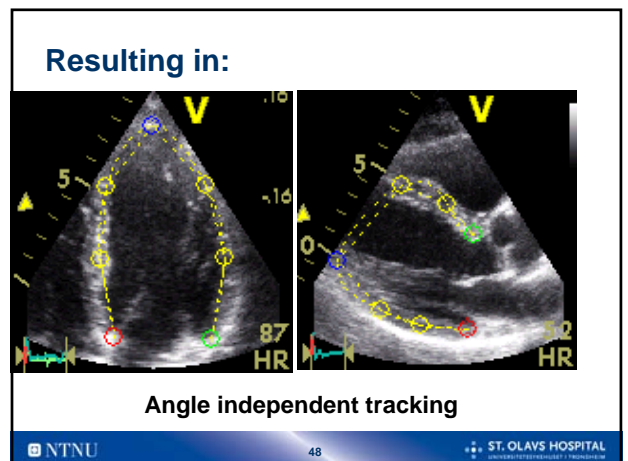
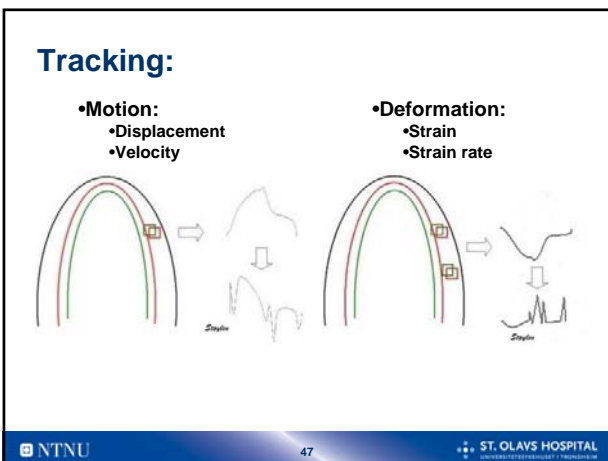
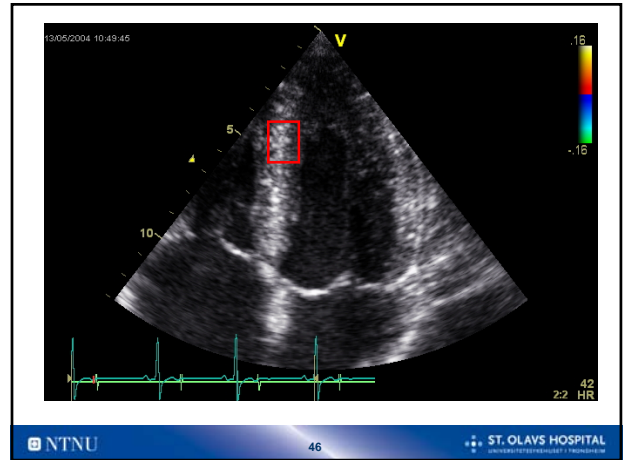
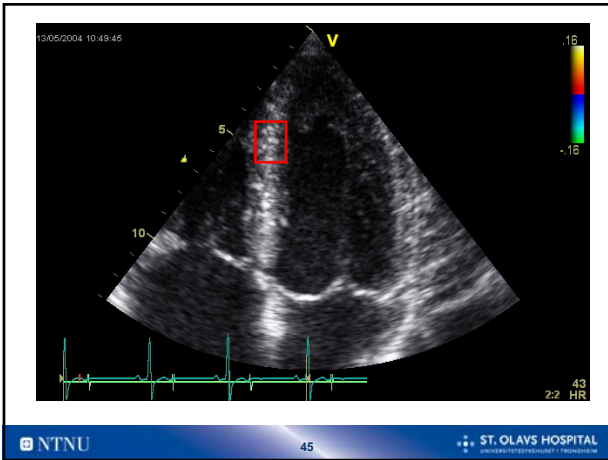
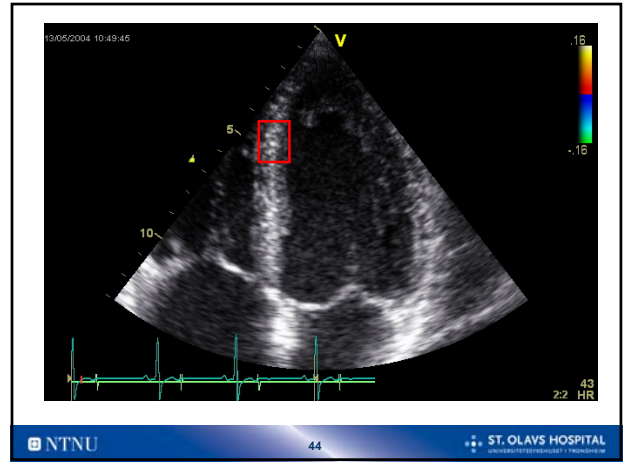
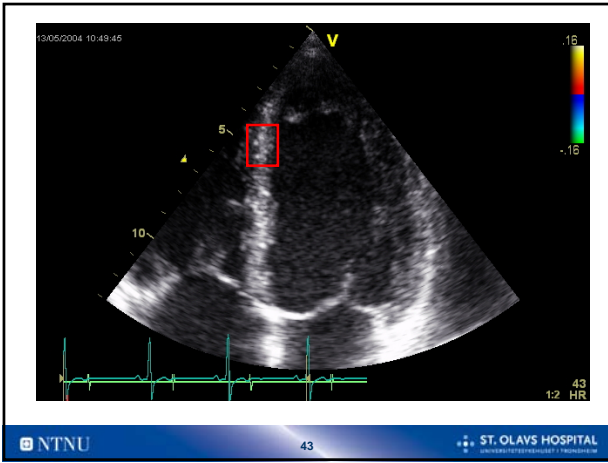
Thus the kernel can be tracked from one frame to the next:



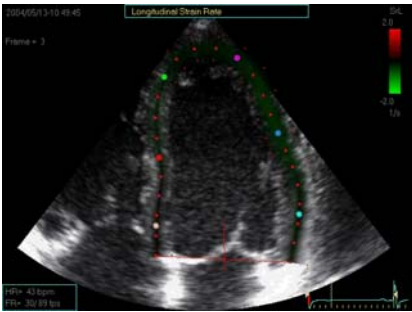
Tracking algorithms:

- Sum of absolute differences:
 - $SAD = \sum (K - Kt) = \sum (|K(x,y) - Kt(x-t,y-u)|)$
- Cross correlation:
 - $R = \sum (|K(x,y) \times Kt(x-t,y-u)|)$

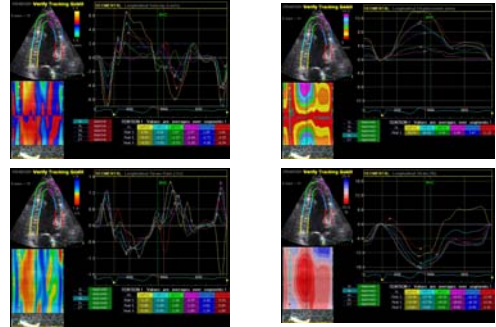
Bohs & Trahey 1991



"2D strain":



One dataset, four modalities:



Vevsdoppler vs. Speckle tracing

- | | |
|--|---|
| <ul style="list-style-type: none">• Very well documented• Lacks somewhat in user friendliness• High frame rate• Poor lateral resolution• Angle dependent• Moderately smoothing dependent• Pitfalls | <ul style="list-style-type: none">• Fairly well validated• Little clinical documentation• User friendly• Low frame rate; may be HR dependent• Angle independent• Sensitive to reverberations and drop outs• Highly smoothing dependent• Strain measurable in all directions<ul style="list-style-type: none">– Little validation so far– No documentation of added clinical value |
|--|---|