Spektraal-Doppler. Lainetekuju.

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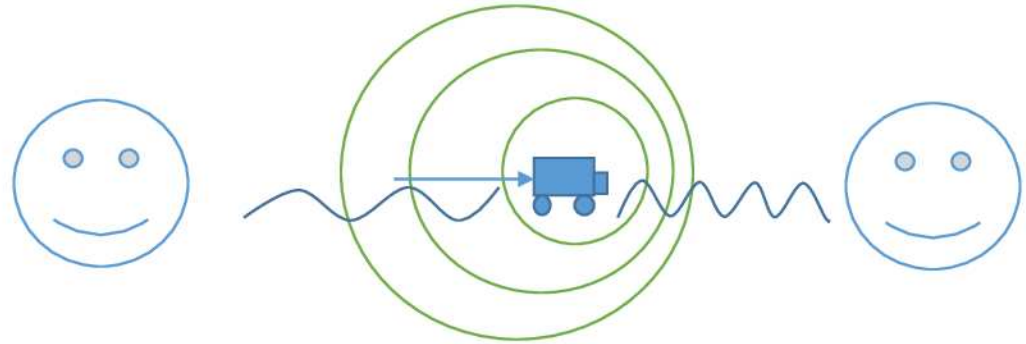
I aasta resident

Kiire meeldetuletus



Doppleri efekt - registreeritav helilaine sagedus sõltub lainete allika ja vastuvõtja liikumise kiirusest ja suunast.

Ultraheli uuringul:

- Värvi-Doppler
- Spektraal-Doppler

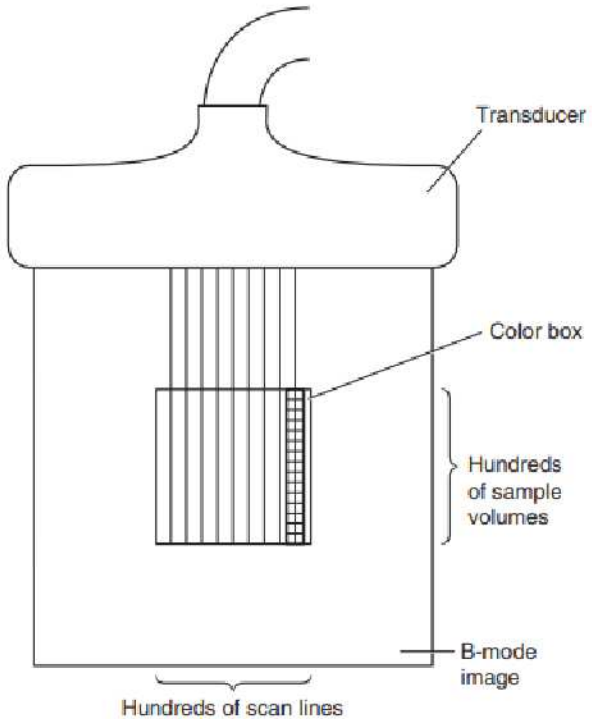
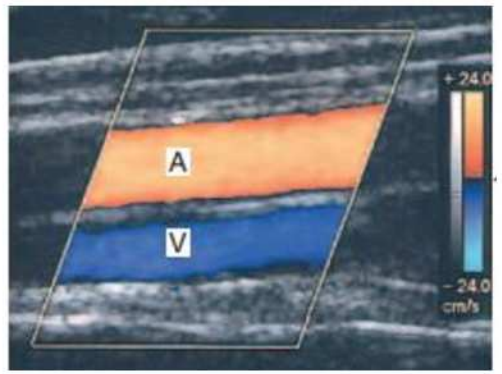


Figure 4.1 The color flow image is created by detecting the back-scattered ultrasound from hundreds of sample volumes along hundreds of different scan lines.



- CW (pidevlaine)

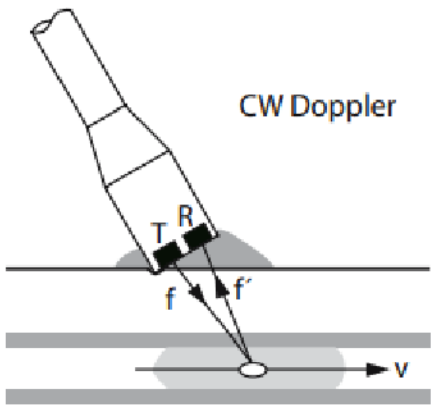


Fig. 1.2. Schematic representation of continuous wave (CW) Doppler ultrasound. Ultrasound pulses are continuously emitted by the transmitter (*T*) and return to the receiver (*R*) with the respective frequency shifts after reflection by the red blood cells moving at different velocities

- PW (pulsslaine)

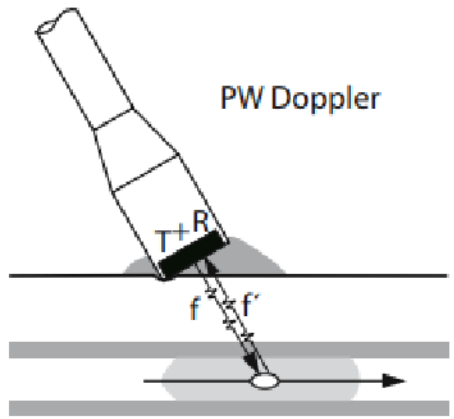


Fig. 1.3. Schematic representation of pulsed wave (PW) Doppler ultrasound. The transducer alternately emits short ultrasound pulses (*T* transmitter) and records the reflected echoes at defined intervals (*R* receiver)

Doppler nurk

Ultrahelikiire langemisnurga teadmine võimaldab arvutada tegeliku voolukiiruse Doppleri nihke põhjal

- Optimaalne <60 kraadi
- 90 kraadi – signaali pole
- >60 kraadi – tulevad suured mõõtmisvead

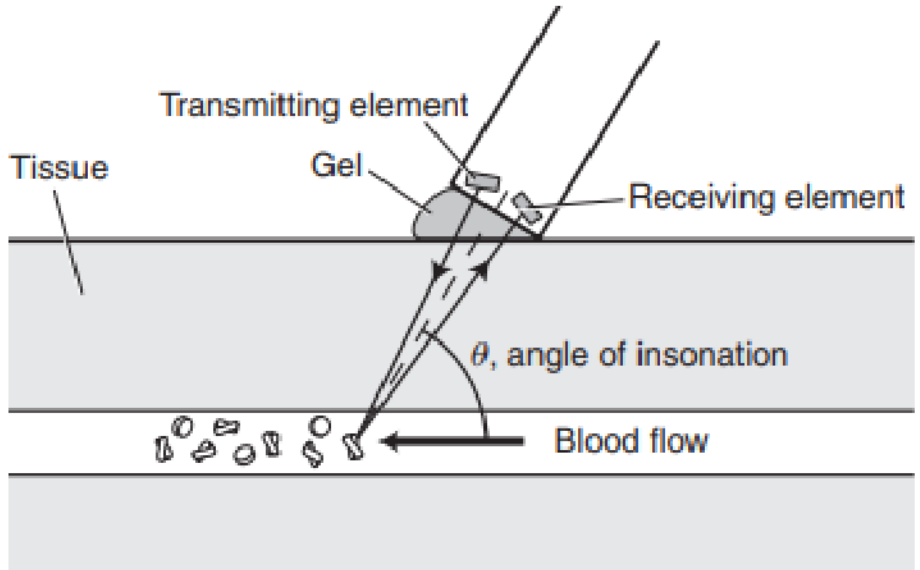
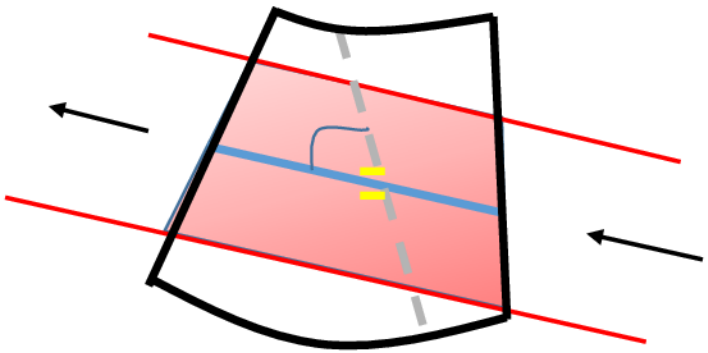
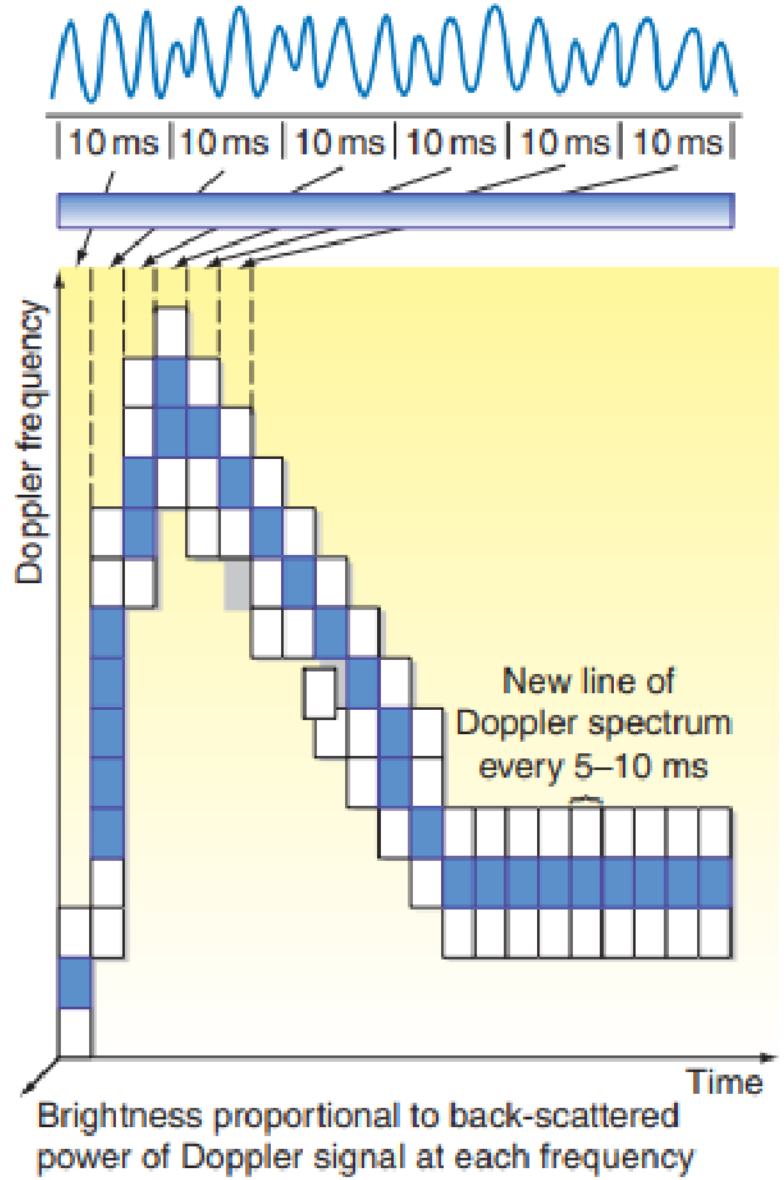


Figure 3.2 Simple Doppler ultrasound instruments use transducers consisting of two piezoelectric elements, one to transmit ultrasound and the other to receive the returning echoes back-scattered from the moving blood cells.

Spektraal-Doppler



Doppleri signaali spektraalanalüüs võimaldab demonstreerida signaalis olevaid sagedusi järjestikuste spektritena. See loob ekraanile graafikut vere punaliblede kiirusemuutustest aja jooksul.



Spektraal-Doppleri graafik

Y teljel – kiirused (mida kiirem, seda isojoonest kaugemal)

Kiiruste vahemiku näitab joone paksus  vs 

X teljel – aeg

Vool anduri suunas isojoonest kõrgemal, andurist eemale aga nulljoonest madalamal.

Aliasing

- sageduse vale hinnang signaali ebapiisava valimivõtu tõttu
- võib juhtuda kui anduri poolt saadetav Doppleri signaali sagedus on kaks korda väiksem peegeldunud maksimaalsest sagedusmõõdust.

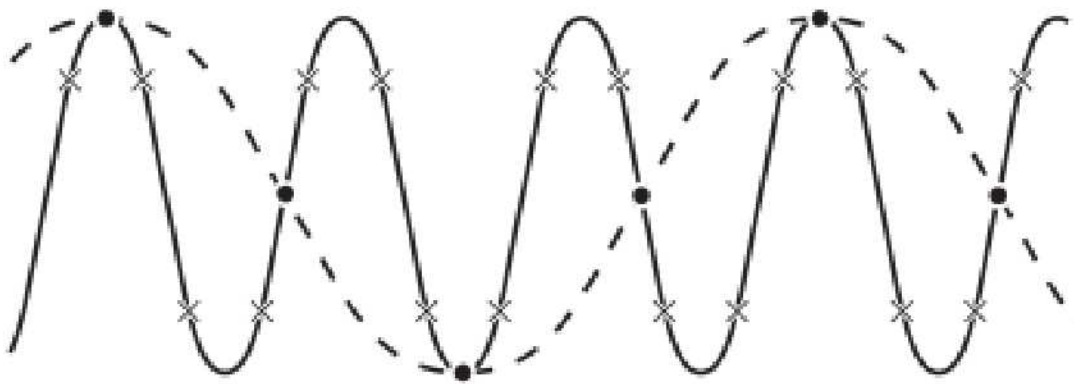
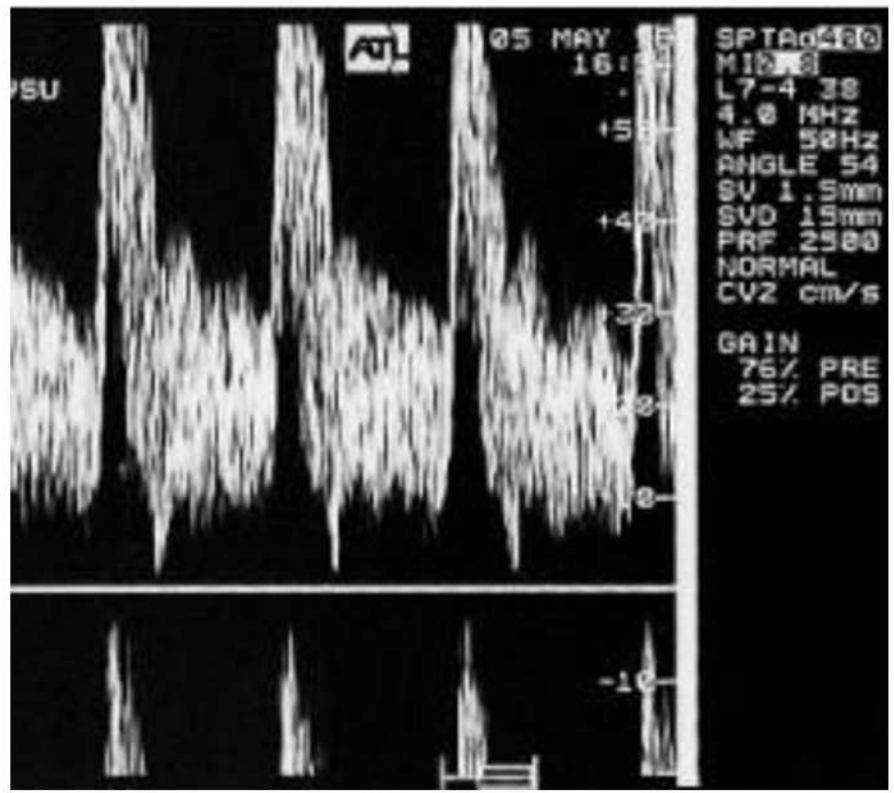


Figure 3.13 Aliasing. The frequency of a simple sine wave (solid line) can be underestimated (dashed line) when the signal is sampled less than twice in a complete cycle.



Verevool veresoontes

Laminaarne vool

- voolu põhjustab rõhuerinevus toru kahe otsa vahel
- vedelikukihid liiguvad korrapäraselt, eri kiirustega kuid teineteisega segunemata. Vahetult seinapidiselt on hõõrdumistegur suurim ja voolukiirus null, keskteljel maksimaalne

Turbulentne vool

- vedelikuosakeste korrapäratu liikumine ja vedelikukihtide intensiivne segunemine.

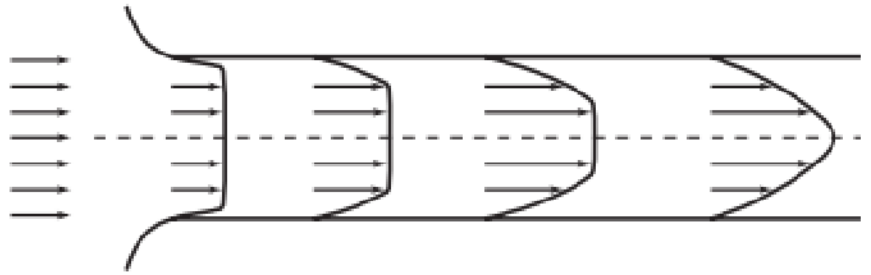


Figure 5.5 The change in velocity profile with distance along a vessel from a blunt to a parabolic.

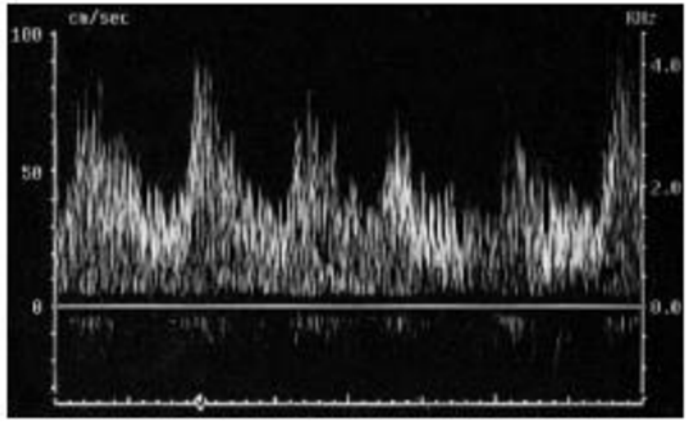


Figure 5.20 Doppler waveform demonstrating turbulent flow.

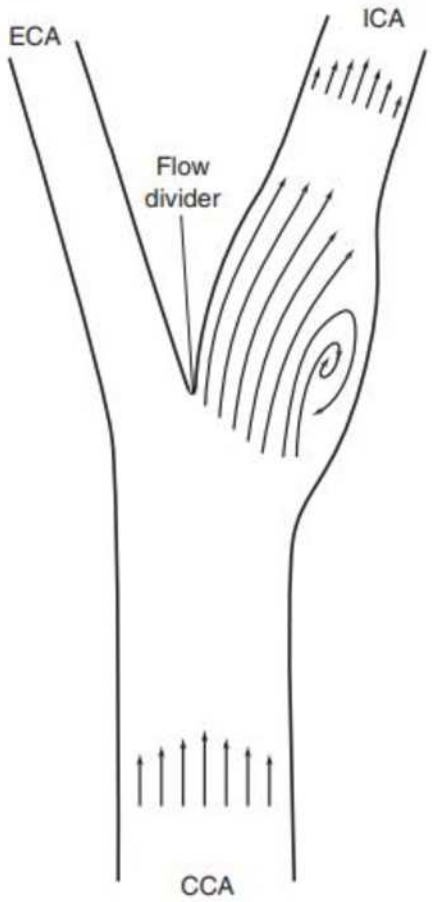


Figure 5.13 Schematic diagram of the velocity patterns commonly observed in the normal carotid bifurcation. The velocity profile is flat and symmetric in the CCA and flat but slightly asymmetric in the ICA. In the carotid bulb the velocities are highest near the flow divider. Flow separation with flow reversal is observed on the opposite side to the flow divider. (From Reneman et al 1985 Flow velocity patterns in and distensibility of the carotid artery bulb in subjects of various ages. Circulation 71(3): 500–509, with permission.)

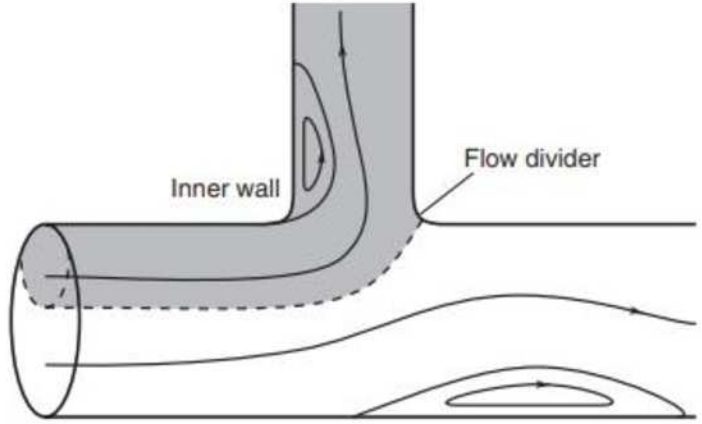


Figure 5.14 Flow in a right-angle junction. The dashed line shows the surface that divides fluid flowing into the side branch from that continuing down the parent vessel. (After Caro et al 1978, with permission.)

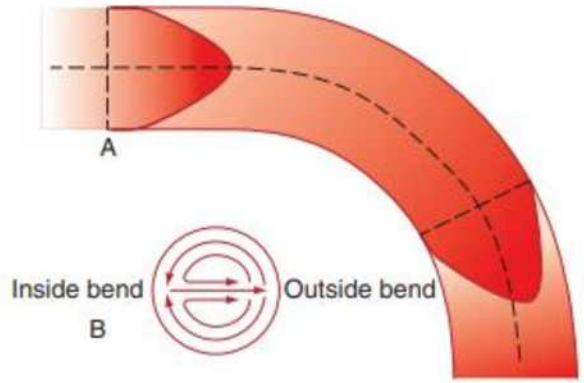


Figure 5.15 A: Distortion of parabolic flow caused by tube curvature. B: Secondary flow, in the form of two helical vortices. (After Caro et al 1978, with permission.)

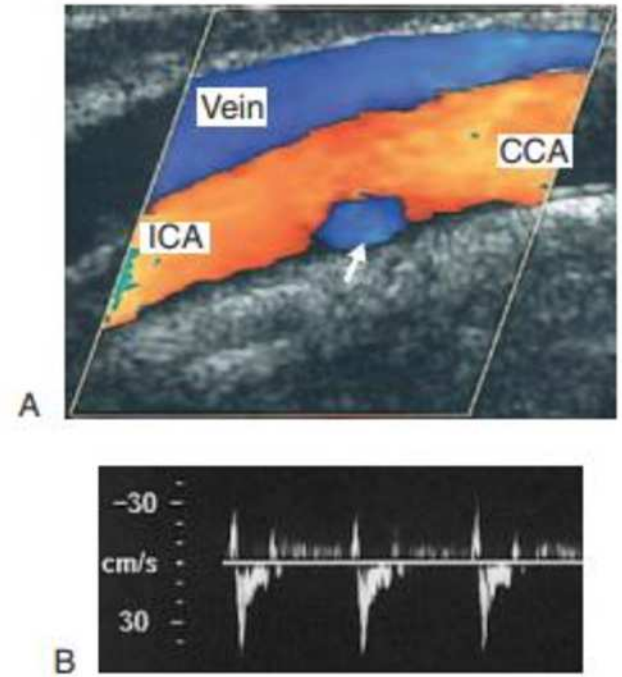


Figure 5.12 A: Color flow image showing reverse flow in the origin of a normal internal carotid artery. B: Spectral Doppler waveform obtained from the area of flow separation shown by the arrow in A.

Spektraal-Doppleri lainetekuju

Erinevatel veresoontel on erinev lainetekuju

Arterites olulisemaks faktoriks on varustusala verevajadus

1. Madala resistentsusega ja pidevat veresissevoolu vajavad varustusalad – aju, maks, neerud
2. Kõrge resistentsusega varustusalad, on demand verevarustusega – lihaseid ja nahka varustavad arterid, perifeersed jäsemete veresooned

RI – Resistentsusindeks

- Varustusala resistentsus uuritavast kohast distaalsemale

RI= (S-D)/S (S-süstoolne tippkiirus, D-diastoolne tippkiirus)

RI < 1 (forward End Diastolic Flow)

RI = 1 (no EDF)

RI > 1 (reversed EDF)

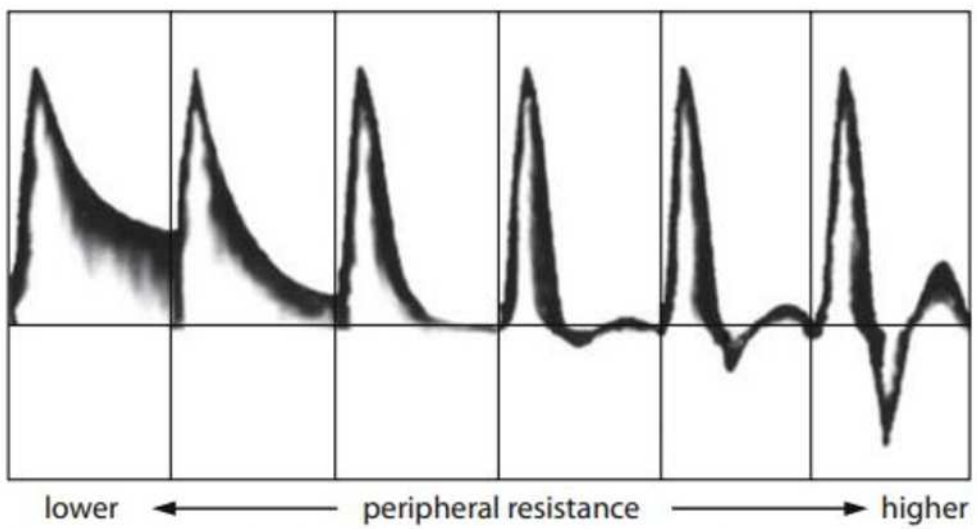
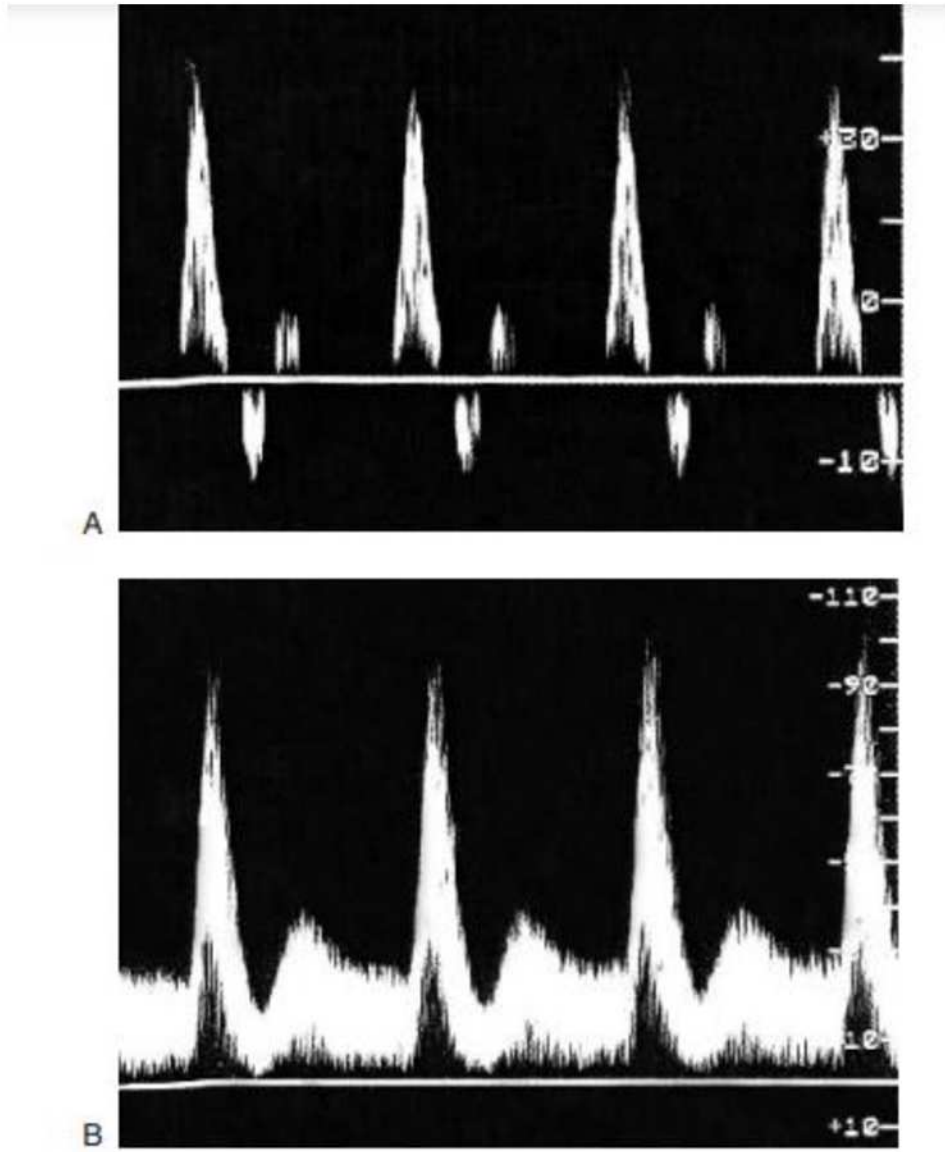


Fig. 1.24. Effect of peripheral resistance on the Doppler waveform. Pulsatility increases with peripheral resistance

A.Dorsalis pedis verevool

A – normaalne trifaasiline vool rahuolekus

B – monofaasiline hüpereemiline vool koormusel



Spektraal-Doppleri lainetekuju

Veenides olulisteks faktoriteks

- rõhugradiendid
- rõhumuutused rindkeres ja kõhuõõnes – hingamine, kõhu punnitamine
- gravitatsioonijõud
- lihasaktiivsus
- lähedus südamele (mida südamele lähedam, seda rohkem avaldub mõju parema südamekoja rõhumuutused)

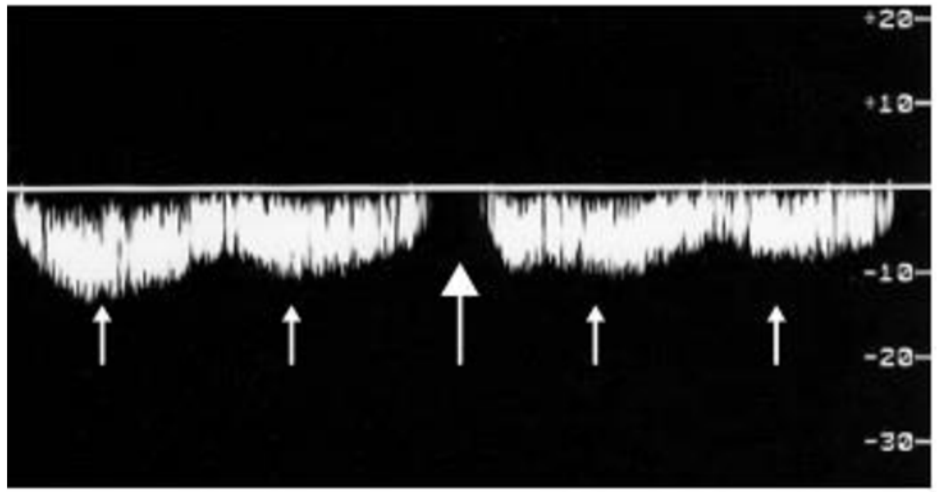
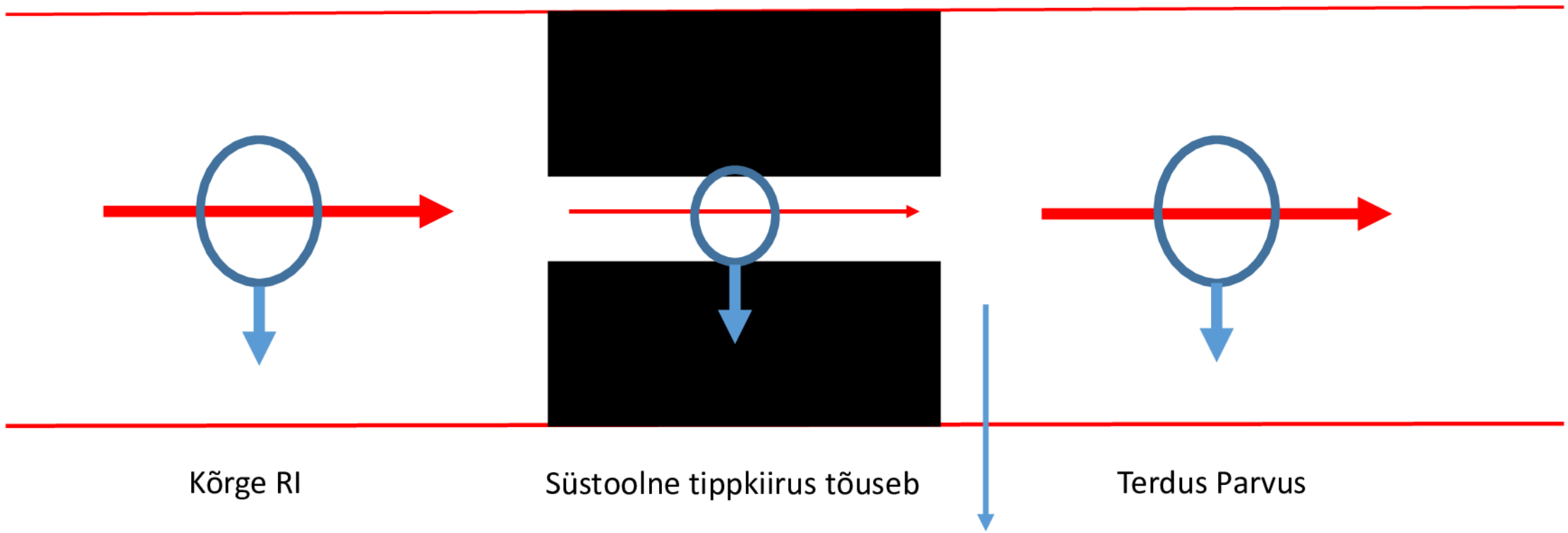


Figure 5.22 Doppler waveform demonstrating the effect of respiration on the blood flow in the common femoral vein. The large arrow indicates the cessation of flow during inspiration and the small arrows show small changes in flow due to the cardiac cycle, which may not always be seen in the common femoral vein.

Stenoos


Kõrge RI
Süstoolne tippkiirus tõuseb
Terdus Parvus
Turbulentse voolu tõttu spektri laienemine

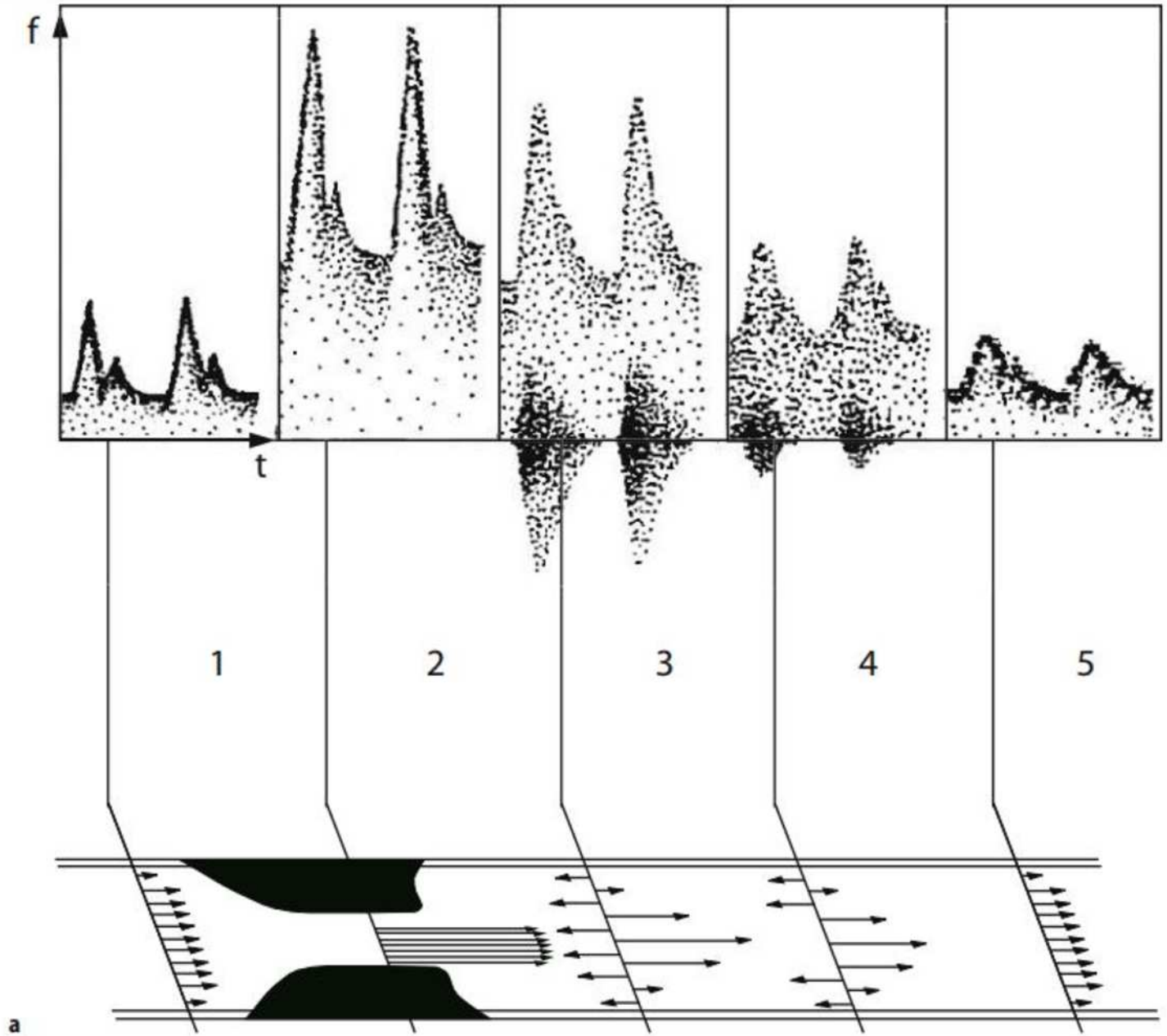


Fig. 1.25. a Impact of flow in and around a stenosis on the Doppler waveform (A.carotis interna stenosis):
1 prestenotic (laminar, pulsatile);
2 intrastenotic (plug profile, maximum acceleration of flow depending on diameter reduction);
3 immediately poststenotic (pronounced turbulence, accelerated flow);
4 poststenotic (deceleration of flow, residual turbulence);
5 further downstream from stenosis (relamination of flow but decreased pulsatility, flattened waveform with larger diastolic component).

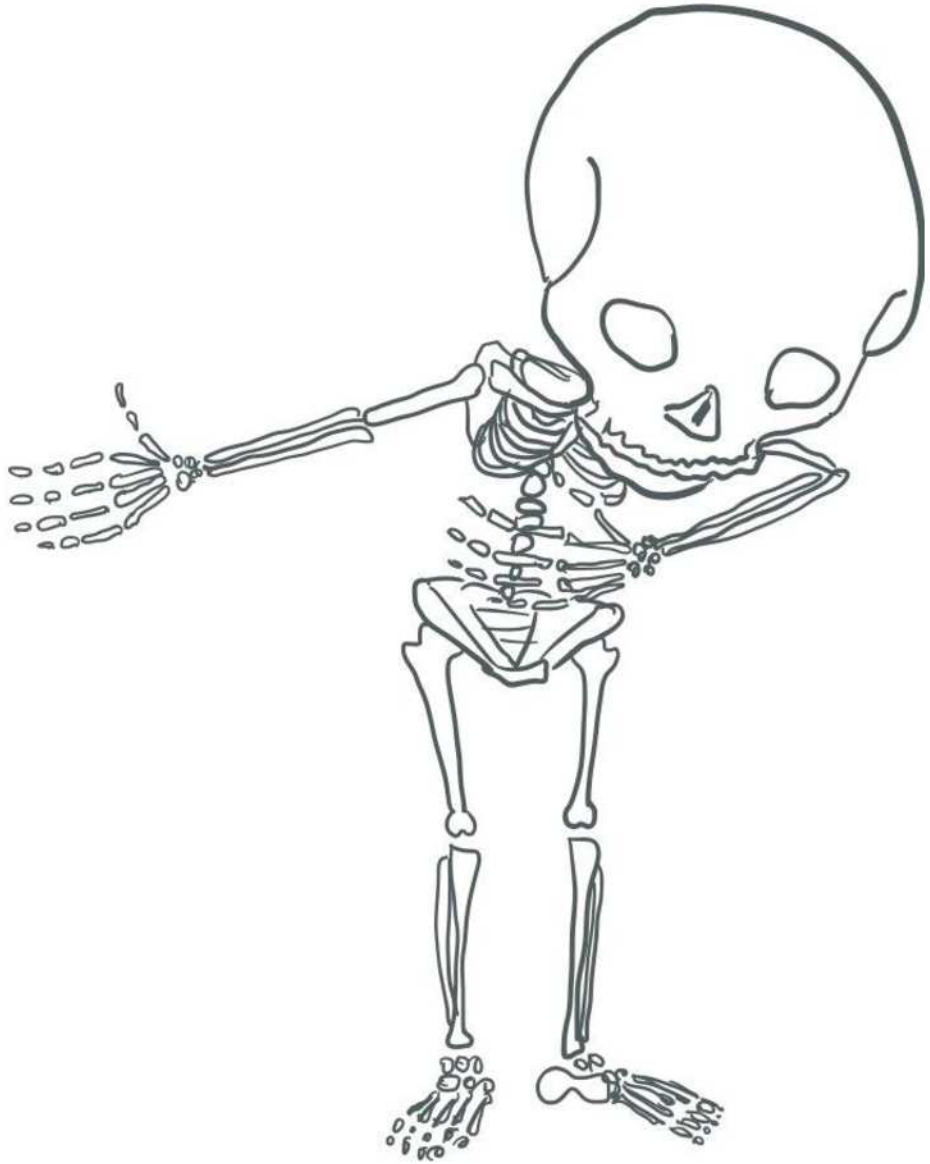
“Tardus Parvus”

- Tardus - aeglane süstoolne tõus
  - Piigini > 70 ms

- Parvus - nõrk amplituud
  - Madal RI

Kasutatud allikad

- Peripheral Vascular Ultrasound - How, Why And When (Abigail Thrush, Timothy Hartshorne)
- Ultrasonography in Vascular Diagnosis A Therapy-Oriented Textbook and Atlas (W. Schäberle)
- Radiopaedia. Doppler waveforms



Aitäh tähelepanu eest!