Image optimisation

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No disclosures
Monitor:
Adjust the contrast and brightness so that both the weakest and strongest gray levels are present on the screen.

System preset:
Standard for your lab to produce uniform appearance of studies. A MUST in colour Doppler maps.
The choice of transducer is very important:

Higher frequency - better resolution less penetration
Lower frequency - poorer resolution better penetration

Change transducer and/or frequency throughout the examination!
2D Imaging

Current machines control much of the image and signal processing.

Differences exist in manufactures with respect to how much operator control is allowed.

Several machines have one single button that can adjust and optimize the image.

HOWEVER: there are some simple adjustments that can fine tune the image.

- Compress
- Gain
- Depth
- iSCAN
- LGC
- TGC
2D Imaging

Gainsetting

- Overall gain
  Adjusts the amplitude of the received signals over the total length of the ultrasound beam.
- Time-gain compensation
  Allows differential adjustments along this length to compensate for the effect of attenuation

Framerate

Number of images per second depends on the number of scan lines and adjusted depth (routine setting ≥ 40 frames per second)
2D Imaging

Correct gain setting

Overall gain

Time gain compensation (TGC)
2D Imaging

Gain setting
- Overall gain
  Adjusts the amplitude of the received signals over the total length of the ultrasound beam.
- Time-gain compensation
  Allows differential adjustments along this length to compensate for the effect of attenuation.

Framerate
Number of images per second depends on the number of scan lines and adjusted depth (routine setting ≥ 40 frames per second)
2D Imaging

Depth 13cm. FR 55Hz
The area of interest fills the screen!

Depth 13cm and < sectorsize = FR 72Hz
(speckle tracking)

Depth 19cm = FR 50Hz

Depth 13cm. decrease in line density
and < sectorsize = FR 88Hz
2D Imaging

Compression

The amplitude range of the reflected signal is compressed into a range of values from white to black.

Tissue Harmonic Imaging

In tissue harmonic imaging the harmonic frequency energy is generated as the ultrasonic wave propagates through the tissue. By processing the received signals the second harmonic is filtered out and displayed.
To provide an image with a gradation of gray levels the number of levels of gray can be adjusted by the compress / dynamic range setting.

Default setting 50 – 55 (iE 33)
2D Imaging

Compression

The amplitude range of the reflected signal is compressed into a range of values from white to black.

Tissue Harmonic Imaging

In tissue harmonic imaging the harmonic frequency energy is generated as the ultrasonic wave propagates through the tissue. By processing the received signals the second harmonic is filtered out and displayed.
Because high signal strength is required to create harmonics, the harmonic signal is mainly generated in the centre of the ultrasound beam. This results in a narrower beam profile and thus a better lateral resolution.

**Default setting second harmonic 1.7 – 3.4 MHz**
The type of processing required to filter out the received harmonic signal does make structures within the heart appear slightly thicker in harmonic as compared with fundamental frequency.
2D Imaging

fundamental – 2nd harmonic

Important

Espically valve leaflets
A beam profile consists of a strong central lobe and weaker side lobes.

The second harmonic frequency produced by these side lobes are of less energy with respect to the central beam.

Result: less artifacts caused by side lobes in second harmonic mode.
Color Doppler Flow Imaging

**Gain Setting**

- Adjusts the degree of amplification of received Doppler signals
- To optimize the flowsignal the gain setting is just below the level of random background noise

**Framerate + Velocity range**

- Sector depth
- Sector width
- Line density
- Pulse repetition frequency (PRF)
Reduce 2D gain!
Color flow data is not displayed on the top of structures (including noise due to excessive gain)
Color Doppler Flow Imaging  

Frame rate 20 Hz  

Frame rate 12 Hz  

Increased sector width requires more scan lines resulting in slower frame rate
Color Doppler Flow Imaging

Frame rate 21 Hz

Frame rate 8 Hz
**Color Doppler Flow Imaging**

**frame rate – sector depth**

FR 17 Hz

- Same transmit-receiving time
- No difference in frame rates

FR 29 Hz

- Less transmit-receiving time
- Higher frame rate
Color Doppler Flow Imaging

Low density
FR 19 Hz

High density
FR 12 Hz

A greater number of scanlines results in denser Doppler data but reduces frame rate

frame rate – line density

Mid density
FR 17 Hz
**Color Doppler Flow Imaging**

- **Low density**
  - FR 19 Hz

- **High density**
  - FR 12 Hz

- **Mid density**
  - FR 17 Hz

**Frame rate – line density**

- **Low density**
  - High frame rate

- **High density**
  - Low frame rate

**Default setting mid density**
Low velocity scale causes aliasing of low velocity flow in the color display and can create a variance display even in laminar flow.
Color Doppler Flow Imaging

velocity range

VR 91 cm/s

VR 61 cm/s

VR 30 cm/s
Color Doppler Flow Imaging

- VR 91 cm/s
- VR 61 cm/s
- VR 30 cm/s
- Default setting velocity scale 60 cm/s

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Erasmus MC
Color Doppler Flow Imaging

VR 61 cm/s

VR 38 cm/s
Color Doppler Flow Imaging

VR 63.9 cm/s

VR 30.8 cm/s

velocity range
Color Doppler Flow Imaging

Ventricular flow filling the trabeculated sections of the myocardium

VR 38 cm/s
VR 61 cm/s
Color Doppler Flow Imaging

- VR 63 cm/s
  - Mid line density
  - FR 17 Hz

- VR 46 cm/s
  - High line density
  - FR 17 Hz

- VR 46 cm/s
  - High line density
  - FR 11 Hz

To optimize low velocity flow:
- reduce velocity scale
- increase line density
- decrease sector width
Pulsed Wave Doppler sample volume position
Standard settings pulsed – continuous wave Doppler

Filter setting

High pass filters eliminate low frequency Doppler shifts

Baseline shift

Baseline shift resolves aliasing

Velocity range

Optimize for precise velocity measurements

Gain setting

Too high gain setting overrate velocity measurements
Continuous Wave Doppler

**Gain Setting**

Vmax 3.2 cm/s
Max PG 41 mmHg
Mean PG 24 mmHg
VTI 83 cm

Vmax 3.5 cm/s
Max PG 50 mmHg
Mean PG 29 mmHg
VTI 94 cm
CWD Aortic valve
PG 82 mmHg
VTI 96.1 cm
(LVOT 17 mm)

PWD LVOT
VTI 36.5 cm
AVA 0.86 cm²
correct gain setting

VTI 44.3 cm
AVA 1.04 cm²
higher gain setting
As a sonographer you should be **continually changing**

the system settings and transducer frequency

**to optimise**

the image throughout the echocardiographic examination
2D Imaging

2nd Harmonic
Gain 63%

Fundamental
Gain 63%

Fundamental
Gain 49%

Energy

\[ f_0 \quad 2f_0 \]

--- Transmitted pulse
--- Pulse after propagation

Erasmus MC
2D Imaging

Fundamental

2nd Harm. 1.4–2.8Mhz

2nd Harm. 1.7–3.4Mhz

2nd Harm. 2.1–4.2Mhz

Erasmus MC
2D Imaging

fundamental – 2\textsuperscript{nd} harmonic

2\textsuperscript{nd} Harmonic

Fundamental

2\textsuperscript{nd} Harmonic

Fundamental

Erasmus MC
PRF (velocity range) and wall filters are linked controls

Low PRF setting use a low wall filter and therefore low velocity flow is visible