Image Optimization: The Sonographer’s Responsibility

Prepared by
Cathy Daniels, EdD, RTR, RDMS, RDCS, RVT
Image Optimization: The Sonographer’s Responsibility
Cathy Daniels, EdD, RTR, RDMS, RDCS, RVT

Disclosure Information:

I have no financial relationships to disclose.

I will not discuss off label use and/or investigational use in my presentation.

I am the Director of Sonography Programs at Johnston Community College.
Objectives

- Learn what image optimization encompasses and why it is important
- Discern how the image needs to be improved and which tools will provide the needed enhancements
- Learn tips for optimal image optimization
What is Image Optimization?

“The use of various knobs or toggles to improve the visual quality of a diagnostic ultrasound image”

Source: https://upload.wikimedia.org/wikipedia/commons/2/2f/CRL_Crown_rump_length_12_weeks_ecografia_Dr._Wolfgang_Moroder.jpg
Why Optimize the Image?

- Facilitates correct interpretation
- Interactive questions on certification boards
- Expected that you optimize ALL images as a professional sonographer

Source: https://www.google.com/search?site=imghp&tbm=isch&q=image%20optimization%20grayscale&tbs=sur:fc#imgrc=2SuoCC2SCOVVVM%3A
1.4.9

Recognizes sonographic characteristics of normal and abnormal tissues, structures, and blood flow; adapt protocol as appropriate to further assess findings; **adjusts scanning technique** to optimize image quality and diagnostic information.

Source: www.sdms.org
It’s YOUR responsibility as a sonographer to optimize the sonographic image.

AVOID the ‘easy button’ as it does not always make the image best. A machine cannot assess the image like a professional sonographer can.
ACR Guidelines (Section IV. Documentation) indicates that “The initials of the operator should be accessible on the images or electronically on PACS. Images should be labeled with patient identification, facility identification, examination date, and image orientation.”
- Upper Left corner of image
- Not over any anatomy or doppler waveform
- Never ‘diagnose’ on an image
- Indicate the following:
  - organ/area of interest
  - scan plane (TRV or SAG)
  - left or right
  - special notations

http://www.em.emory.edu/ultrasound/ImageWeek/images/GB2%20IOW.jpeg

https://2.bp.blogspot.com/_D98CZd-6V0B/TQ7HB3VwGpI/AAAAAAAACJs/DsusWL8N2dU/s1600/fine-calculi-GB-blog-1a.jpg


https://www.ed.virginia.edu/courses/rad/edus/text%20jpegs1/4c.jpg
Suggested...

- Organ
- TRANS or SAG
- Patient position
- Special notes
Center the Area of Interest
Same for the Ultrasound Image
Patient Positioning

- Abdominal studies should rarely be completed with patient only SUPINE.
- Be creative with transducer manipulations and windows.
- Remove the pillow for carotids and improve distal imaging of ICA.
- Scan from the posterior window for a better ICA.
Critical Thinking Skills

- Know the Protocol
- Critique your images as you go (have an analytical process)
- Evaluate your image BEFORE you save it
- Go off axis when needed
- Video clip it if a still image cannot tell the story
- If you question what you see, so will the interpreting physician. Go ahead and answer the question.
- Always be humble enough to get someone else to look at it.
So How Do I Optimize the Image?
(without using the ‘easy button’)
Many Tools Available

- Exam/Presets
- Transducer selection
- Frequency
  - High/Low/MultiHz
  - Harmonics
- Depth
- Focus
- Gain Controls
  - Overall, TGC, LGC
- Sector Size
- Magnify/Zoom
- Compression/Dynamic Range
- B-color/Image Colorization
- Post-processing
- Sweep/Video Clip
Control Knobs

- Left: Lessens or decreases
- Increases

Toggles

- Usually Increases
- Usually Decreases
TGC Slide Pods

Left Lessens “darker”

Right Bright “brighter”
Exam Presets

- Pre-established parameters specific to study
- Use as a baseline for specific study and adjust accordingly
- Always reset preset before beginning each study
Selecting the Transducer

- Resolution (use high frequency)
  - Axial Resolution (determined by SPL)
    - smaller SPL with High Frequencies
    - better front to back resolution

- Depth (use low frequency)
  - Try utilizing the ‘multi-hertz’ feature too.
  - Consider the size of near field vs. far field with the anatomy seen
Gen-L (low freq)

Gen-M (higher freq)
Depth

- Shallow versus deep
- 2 finger widths from bottom of anatomy to bottom of image
- Do not clip anatomy in image
- Utilize depth throughout study

Note: If you change depth, adjust **FOCUS** too.
Clipped Image

Wasted Far Field
Abdominal Aorta (SAG)

Example of why depth (and focus) should change throughout the exam
Perpendicular to Walls

- 90° to wall produces best reflection
Lateral Resolution

- Determined by Beam Width
- Use focus (narrowest part of sound beam) to optimize beam width
- Use multi-focus but at the sake of temporal resolution
Focus

- Position at the level of or just beyond the area of interest (narrower Beam Width resulting in better Lateral Resolution)
- Enhances image in a specific region
- Utilize throughout exam as depth changes
- Multi-focus is best used with non-moving structure (multi-focus decreases Temporal Resolution by slowing down the Frame Rate)
Single Focus vs Multi-focus
Gains

- 2D Overall Gain
- Doppler Gain
- Color Gain
Overall Gain

- The **whole image** needs correction
- Under gain (too little gain)
- Over gain (too much gain)
- % correction needed to optimize
Doppler Gain

- Enhances the doppler spectral display
- Useful with minimal or faint velocities

Nice background and clean spectral window

Too much
Color Gain

- Enhances the amount of color displayed to improve color fill-in in a vessel

Correct

Too LOW

Too HIGH
Color Wall Filter

Correct

Too HIGH
Doppler works best with lower frequencies
TGC/LGC

- “cm” markers
- Compensates for signal attenuation at different depths so all signals have similar intensity regardless of distance traveled
- Use according to image needs
  - Near field
  - Middle of image
  - Far field
- LGC compensates on sides
Normal

TGC banding
Adjusting TGC can make a vessel ‘pop’
Dual Image: Measurements

- Provides side to side comparison

w/o measurements

WITH measurements
Dual Image: 2D & Color Flow

- Provides side to side comparison

![Dual Image: 2D & Color Flow](image)

w/o color

WITH color
Temporal Resolution

- To image a moving structure as it the movement occurs
- Determined by frame rate
Frame Rate is determined by:

- Imaging depth
- Number of pulses per frame
  - Number of focal points
  - Sector size
  - Line density

- The more work we ask the transducer to do, the more time it takes to do it; thereby slowing the frame rate.
Increase focal points = \downarrow \text{Frame Rate}

Single Focus

Multiple Focal Points
Sector Size

Increase sector size = ↓ frame rate due to more scan lines

Less scan lines require less time and improves temporal resolution
Sector Size

In addition, narrowing the sector size will get rid of unnecessary information and improve overall resolution image.
Line Density

Increase line density = ↓ frame rate but.....

← The image is BETTER because of more scan lines!
Imaging Depth

- Shallow depth = better temporal resolution

Deeper depth requires **more time** for echo to return to Td.
More time = **less** temporal resolution

Greater the depth, less resolution. So scan deep enough to see organ. Don’t waste the far field.
What creates the **BEST temporal resolution**?

- single focal point
- narrow sector size
- low line density
Zoom

- Enlarges the area of interest w/o loss of quality
Dynamic Range or Compression

- **DR** = range of grays between smallest and largest signals

- **Compression** = varying shades of gray due to compressed signals

- Choose between hi/low contrast or gray scale
Range between Smallest - Largest Signals

Normal Dynamic Range

More shades of gray

Less Dynamic Range

Less shades of gray
Benefits of **Color**
B-color/ Image Colorization/Colorize

- the substitution of the basic grayscale image with a hue other than gray in order to improve visual perception of images.
- Not useful when using color flow
- Can also be helpful with doppler spectrum
Different Color Hues
Colorize PW

- May help you see PSV or EDV better
Persistence

Decrease = grainy image

Increase = smoothes image

CAUTION: Increasing PERSISTENCE = ↓ frame rate due to averaging of frames
Edge

- Sharpens
- Lower: smoother, less noise
- Higher: sharper edges
Still Image or Video Clip

- Helpful for presenting information that is best seen in real time versus still image
Doppler Optimization

- Scale
- Baseline
- Wall Filter
Scale (PRF)

- Optimize scale so that the waveform is not too small (decrease scale)
- If PRF is too low, then aliasing occurs.
- Hi PRF….decrease depth
- Doppler scale vs. color scale

Don't make me squint.
Baseline

- Zero level on doppler spectrum or color bar
- Emphasize the side of the baseline for + or – flow direction
- Can be adjusted to help with aliasing

![Correct Baseline](image1.png)

Baseline too HIGH for flow above the line

![Baseline too High](image2.png)
Move the baseline down to emphasize flow above the line.
Wall Filter

- Used to eliminate noise or clutter along the BL
- Decrease the wall filter to allow more echoes
- Increasing the filter takes away information along baseline and may overestimate mean velocities
To Correct PW Aliasing

- Increase scale
- May adjust BL
To Correct Color Aliasing

- Look at the center of the vessel or center of stenotic flow to see aliasing due to velocities faster than the color scale allows.
- Flow is naturally faster in the center of the vessel.
- Increase color scale.
- May adjust baseline.
Sample Volume Size & Location

- Gate Size/Location
  Increase gate size = increases signal-to-noise ratio
- L/C/R (use smallest angle)
- Angle Correct should be parallel to flow
- If fixed 60°, then toe-heel or move Td so vessel “fits”.
Sample Location

Center of Flow

Good window w/o spectral broadening.

Next to vessel wall

Too close to vessel wall; poor angle.
Sample Volume Size

Clean window

+ spectral broadening
Listen for the **BEST** Doppler signal

- SV in center of vessel
- SV not on wall
- Small SV
- Toe-Heel or Heel-Toe (produces smallest doppler angle of incident)
- LISTEN
L/C/R

- Must know direction of flow (toward or away from ❤️)
- Flow toward transducer is most accurate
- Flow away from transducer is underestimated
- 90 degrees = no flow or color
L/C/R

Steered with perpendicular incidence

Good; steered toward flow
Carotid Imaging

Center Steer 90

Toward Flow

Steer Away from flow (underestimates velocity)
Parallel to Flow/Angle Correct

- 0° doppler angle is most correct if parallel to flow
- 45-60° for consistency between studies
- Use angle correct correctly

good.

poor waveform 76°
Perpendicular to Walls

→ 90° to wall produces best reflection
Perpendicular to Flow is **BAD**

PW  

Horizontal vessel

CF  

Color box is perpendicular to flow
Parallel to Flow

- $0^\circ$ to flow yields most accurate velocity
Heel – Toe to Improve PW

Better: ICA is off the baseline more.
Heel – Toe to Improve CF
Scenarios for identifying the best correction needed
- Increase overall gain by 25%
- Decrease overall gain by 50%
- Decrease TGC in the far field by 50%
- Select a higher frequency Td
What’s Wrong?

Need to Use Correct Annotation Methods
Do not ‘diagnose’ on the image.
- Increase overall gain by 25%
- Decrease overall gain by 25%
- Increase TGC in the near field by 50%
- Select a higher frequency Td
- Increase PW scale by 25%
- Decrease PW scale by 25%
- Increase CF scale by 25%
- Decrease filter by 25%
What’s Wrong?

Do not 'diagnose' on the image.
- Increase scale by 50%
- Move baseline up
- Decrease scale by 25%
- Increase color gain by 30%
Remember...

- Every image you submit is a direct reflection of your professionalism and scanning abilities.
- The interpreting physician depends on you. Your patient depends on you.
- Your images and protocol define your credibility as a highly-skilled sonographer.
- Let each image be your....
Thank you for allowing me to share with you today!

Image Optimization: YOUR Responsibility