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How to set up the machine

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Discloser

I have received:

Speaker fees: AbbVie, Bristol Myers Squibb, Celltrion, Johnson & Johnson, Merck Sharp & Dohme, Pfizer, Takeda.

Advisory Board/Consultancy: AbbVie, Bristol Myers Squibb, Johnson & Johnson, Merck Sharp & Dohme

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Thank you to all contributors who helped create this presentation:

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Dr. Marios Katsaros
Dr. Kayal Vizhi
Dr. Federica Furfaro

TODAY'S ROADMAP

HOW TO SET UP THE MACHINE

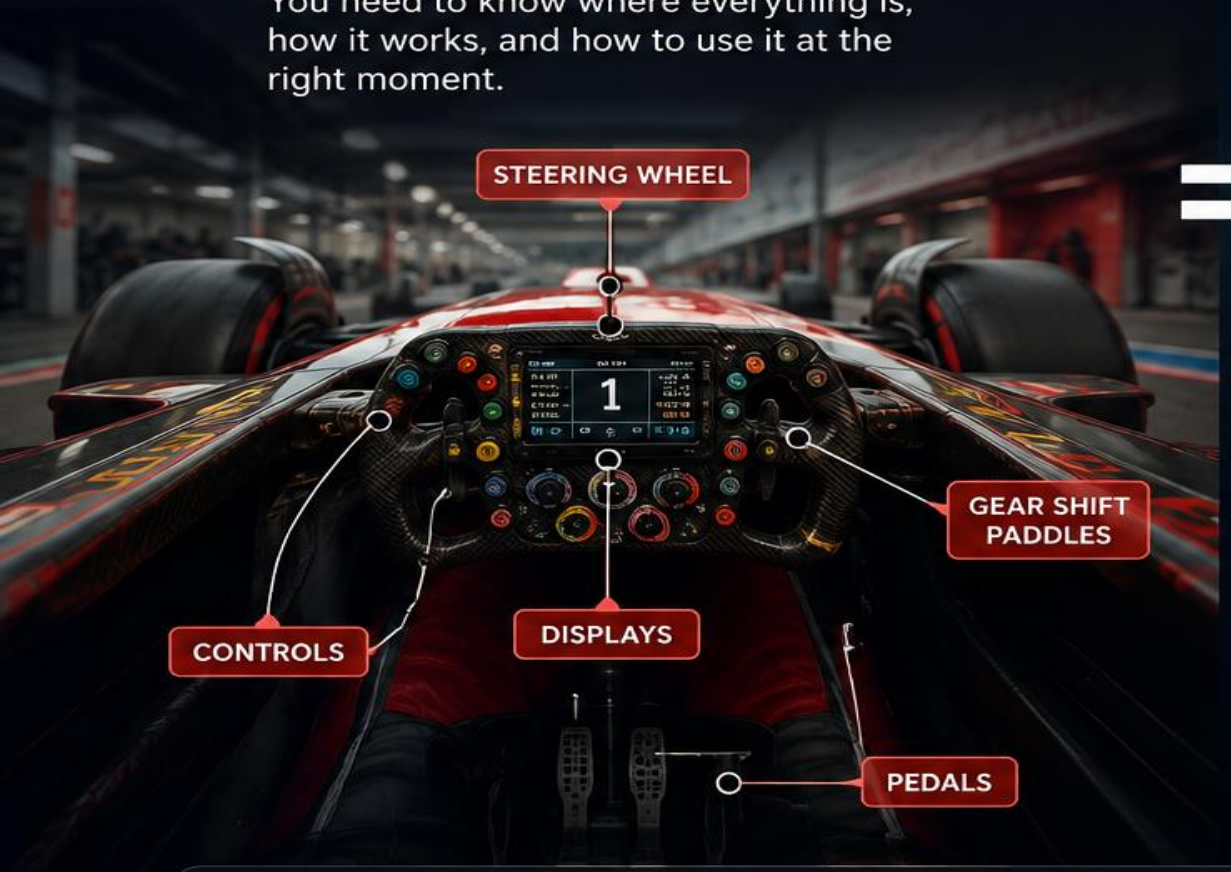
1. **KNOW YOUR MACHINE**
   Get familiar with your ultrasound system
2. **CHOOSE THE RIGHT PROBE**
   Select the appropriate probe for intestinal ultrasound
3. **UNDERSTAND THE PHYSICS**
   Piezoelectricity, frequency, penetration & resolution
4. **MASTER THE MACHINE CONTROLS**
   Depth • Gain • Focus • and more
5. **OPTIMIZE DOPPLER**
   Use Doppler modes to assess bowel vascularity
6. **ACQUIRE THE BEST IMAGE**
   Optimize settings for maximum image quality
7. **RECOGNIZE ARTIFACTS**
   Identify common artifacts and avoid misinterpretation
8. **KNOW THE LIMITATIONS**
   Understand when IUS is less reliable and needs complementary imaging
9. **TAKE-HOME MESSAGES**
   Key points to apply in clinical practice

KNOW YOUR MACHINE

The key to high-quality images

A FORMULA 1 CAR

It's not enough to have the best car. You need to know where everything is, how it works, and how to use it at the right moment.



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AN ULTRASOUND SYSTEM

Knowing your machine allows you to work efficiently, optimize your images and provide the best care for your patients.

No magic button gives a perfect image.

KNOW YOUR MACHINE AND MAKE IT WORK FOR YOU.

CHOOSE THE RIGHT PROBE

Select the appropriate probe for intestinal ultrasound

RIGHT PROBE = RIGHT INFORMATION = BETTER PATIENT CARE

CLINICAL GOAL

Use the probe that gives you the depth and detail you need to answer your clinical question.

KEY DIFFERENCE

FREQUENCY DETERMINES:

Lower frequency = More depth, less detail

Higher frequency = More detail, less depth

Curved
High range

Linear
Mid range

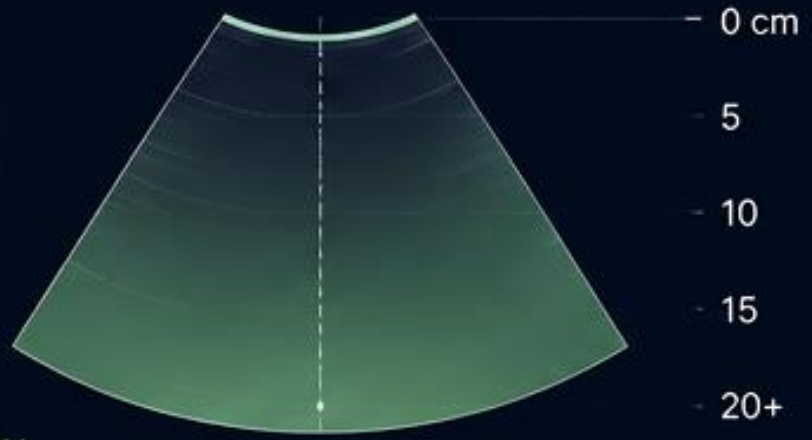
Microconvex
Mid range

Optional, for example, for transperineal ultrasound

CURVILINEAR / CONVEX PROBE

LOW FREQUENCY

3 – 5 MHz



DEEPER PENETRATION

Allows visualization of deeper structures.

LOWER RESOLUTION

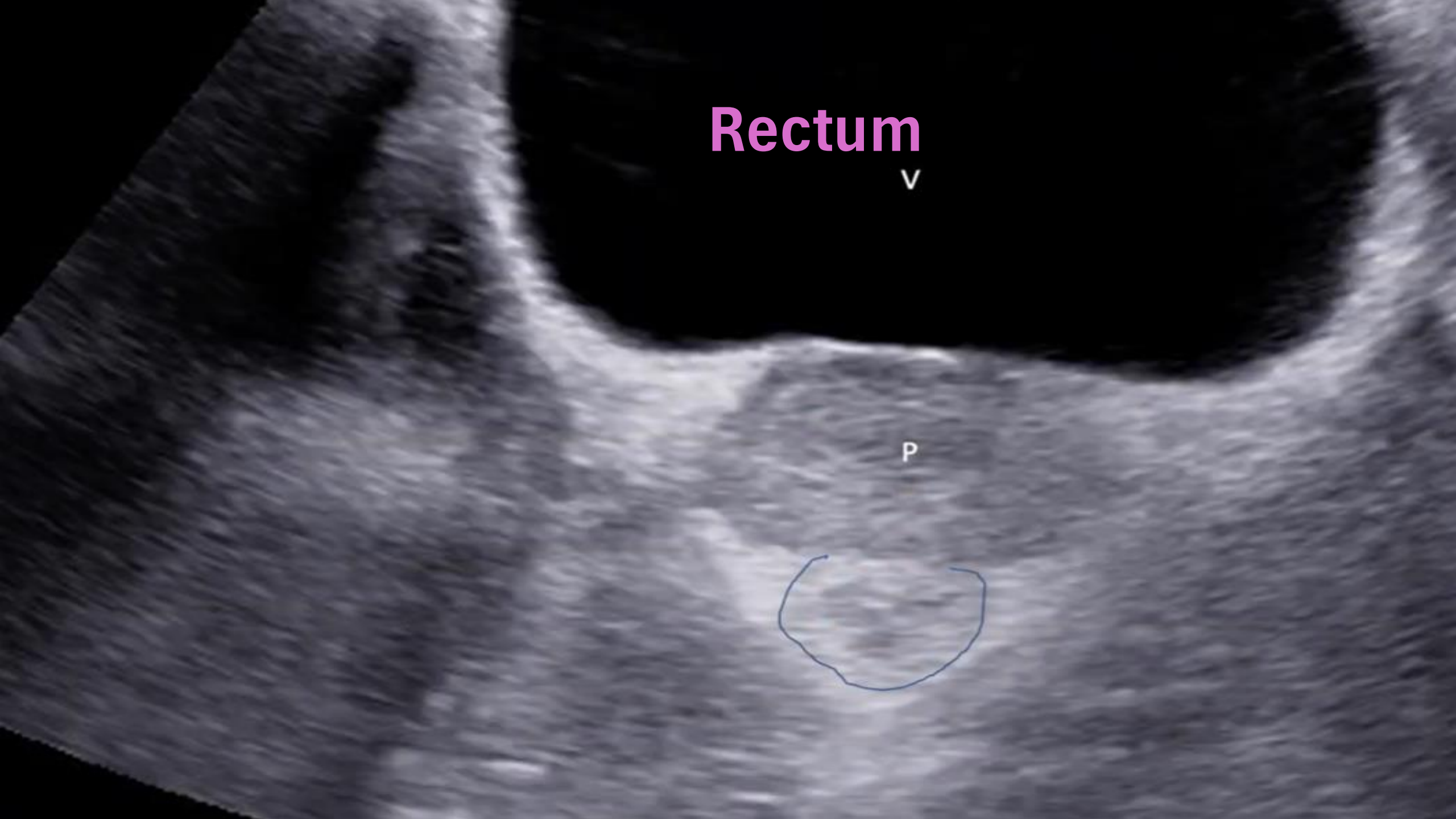
Less detail, but more depth.

BEST FOR

General overview, detection and extension of disease, complications (abscesses, fistulas, stenosis).

IDEAL FOR

Obese patients, deep bowel loops, full abdomen.


Rectum
V
P

LINEAR PROBE

HIGH FREQUENCY

5 – 12 MHz

SUPERFICIAL PENETRATION

Excellent for structures close to the probe.

HIGHER RESOLUTION

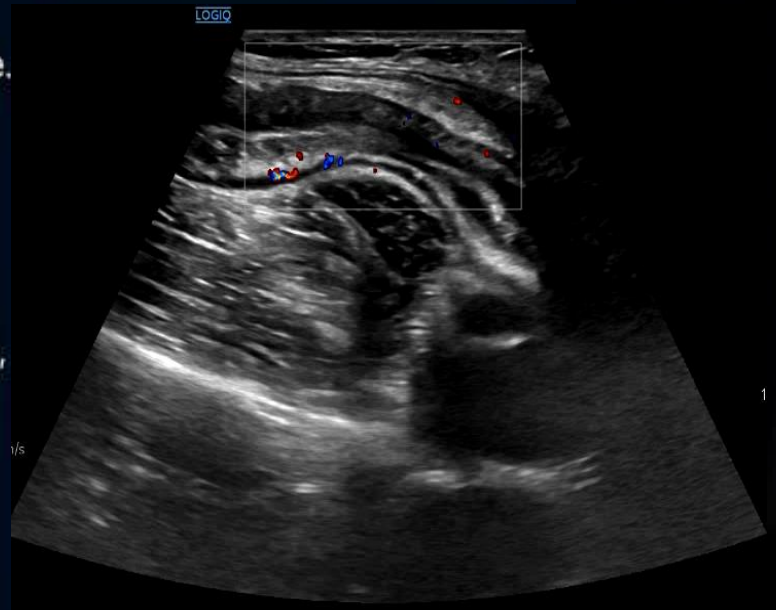
More detail of superficial structures.

BEST FOR

Bowel wall thickness (BWT) measurement, stratification of wall layers, vascularization of the bowel wall.

IDEAL FOR

Evaluating the bowel wall in detail, follow-up, superficial loops.



WHEN TO USE EACH PROBE?

START WITH CONVEX

For initial assessment, mapping the disease, and looking for complications.

SWITCH TO LINEAR

For detailed evaluation of the bowel wall, stratification and follow-up.

REMEMBER

Both probes are complementary. A complete IUS exam uses both!

UNDERSTAND THE PHYSICS

PIEZOELECTRICITY

Ultrasound images are created by the exchange of electrical and sound energy through piezoelectric crystals in the probe.

1 ELECTRICAL ENERGY IN

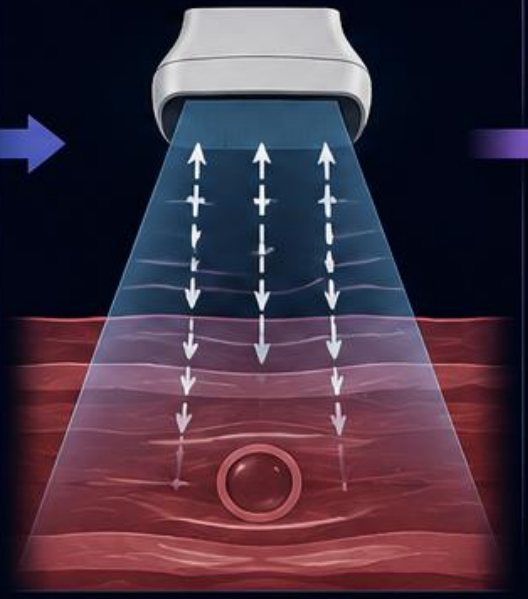
The ultrasound machine sends electrical pulses to the probe.

2 PIEZOELECTRIC CRYSTALS VIBRATE

The piezoelectric crystals vibrate and convert electrical energy into sound waves.

3 SOUND WAVES TRAVEL & REFLECT

Ultrasound waves travel into the body and reflect back when they encounter structures (interfaces).



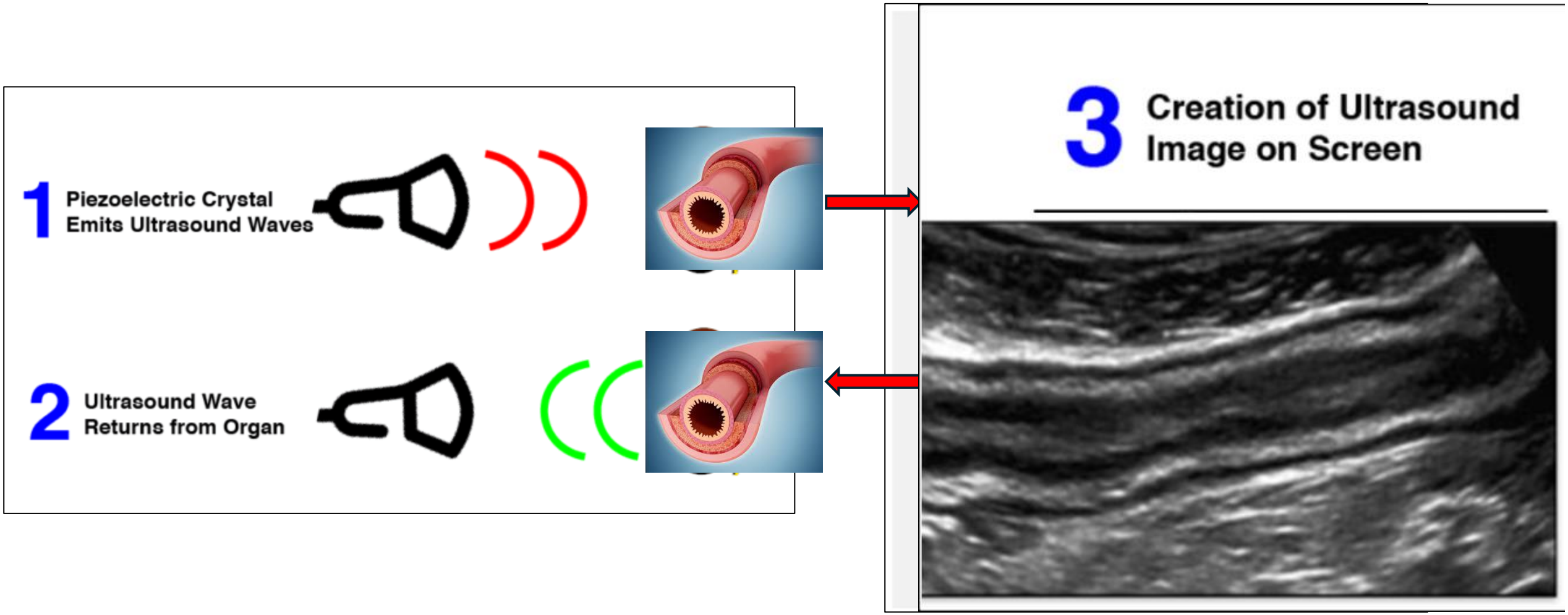
4 ECHOES RETURN TO THE PROBE

The returning echoes deform the crystals, which convert sound energy back into electrical signals.

5 IMAGE IS FORMED

The machine processes the electrical signals and converts them into a real-time ultrasound image.

Piezo-electric effect of ultrasound



UNDERSTAND THE PHYSICS

FREQUENCY

Frequency is the **number of sound waves emitted** per second (Hz).

20 Hz — 5 000 Hz — 20 000 Hz — Frequency (Hz)

INFRASOUND

Inaudible sounds for humans

SOUND (AUDIBLE)

Audible sounds for humans

ULTRASOUND

Inaudible sounds for humans

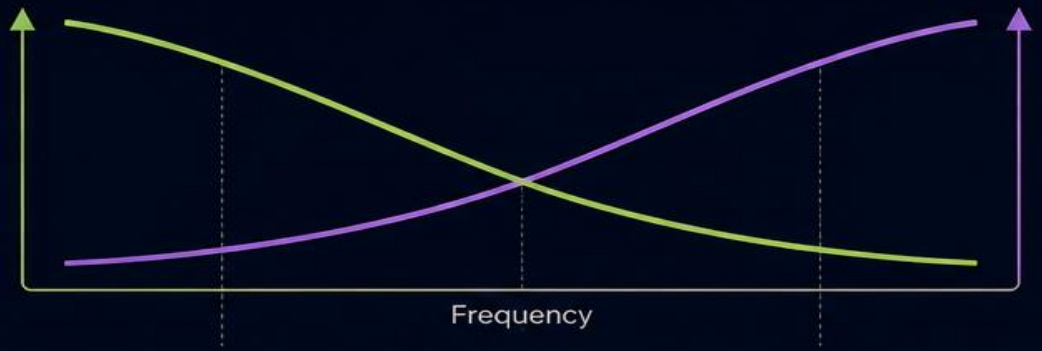
Ultrasound uses high frequencies that humans cannot hear.

This allows us to see structures inside the body.

THE TRADE-OFF: FREQUENCY VS. RESOLUTION AND PENETRATION

PENETRATION

Higher penetration (deeper imaging) with lower frequencies.



RESOLUTION

Higher resolution (more detail) with higher frequencies.

LOW FREQUENCY
(Better penetration, less detail)

MID FREQUENCY
(Balance)

HIGH FREQUENCY
(Better detail, less penetration)

KEY POINT

LOW FREQUENCY
= more depth, less detail

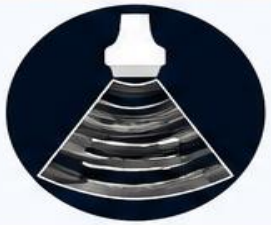
HIGH FREQUENCY
= more detail, less depth

The art of ultrasound is choosing the right frequency for the right clinical question.

MASTER THE MACHINE CONTROLS

B-MODE

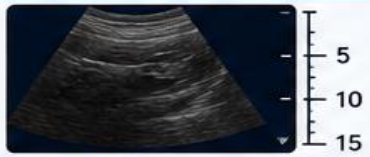
WHAT IS B-MODE?



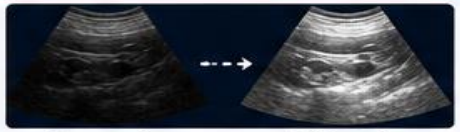
B-mode (Brightness mode) generates a grayscale image that shows the anatomy and the structural relationships of tissues.

KEY CONTROLS

DEPTH
Determines how deep you see.



GAIN
Adjusts the overall brightness of the image.



FOCUS
Optimizes the resolution at a specific depth.

OTHER ADJUSTMENTS

ZOOM · FREEZE · CALIPER · MEASURE · TEXT

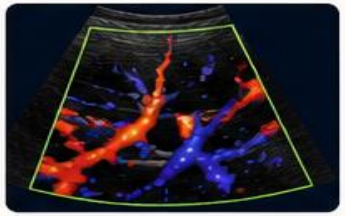
DOPPLER MODE

WHAT IS DOPPLER MODE?

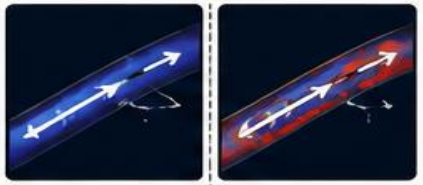
Doppler mode evaluates the movement of blood cells. In **IUS** (Intestinal Ultrasound), it is used to assess vascularity and inflammation in the bowel wall and surrounding tissues.

KEY CONTROLS

COLOR GAIN
Adjusts the sensitivity of color signals. Higher gain increases color signals but may introduce noise.



PRF (PULSE REPETITION FREQUENCY)
Determines the range of velocities that can be detected.
High PRF: detects high velocities but may miss low flows.
Low PRF: detects low velocities but may cause aliasing.



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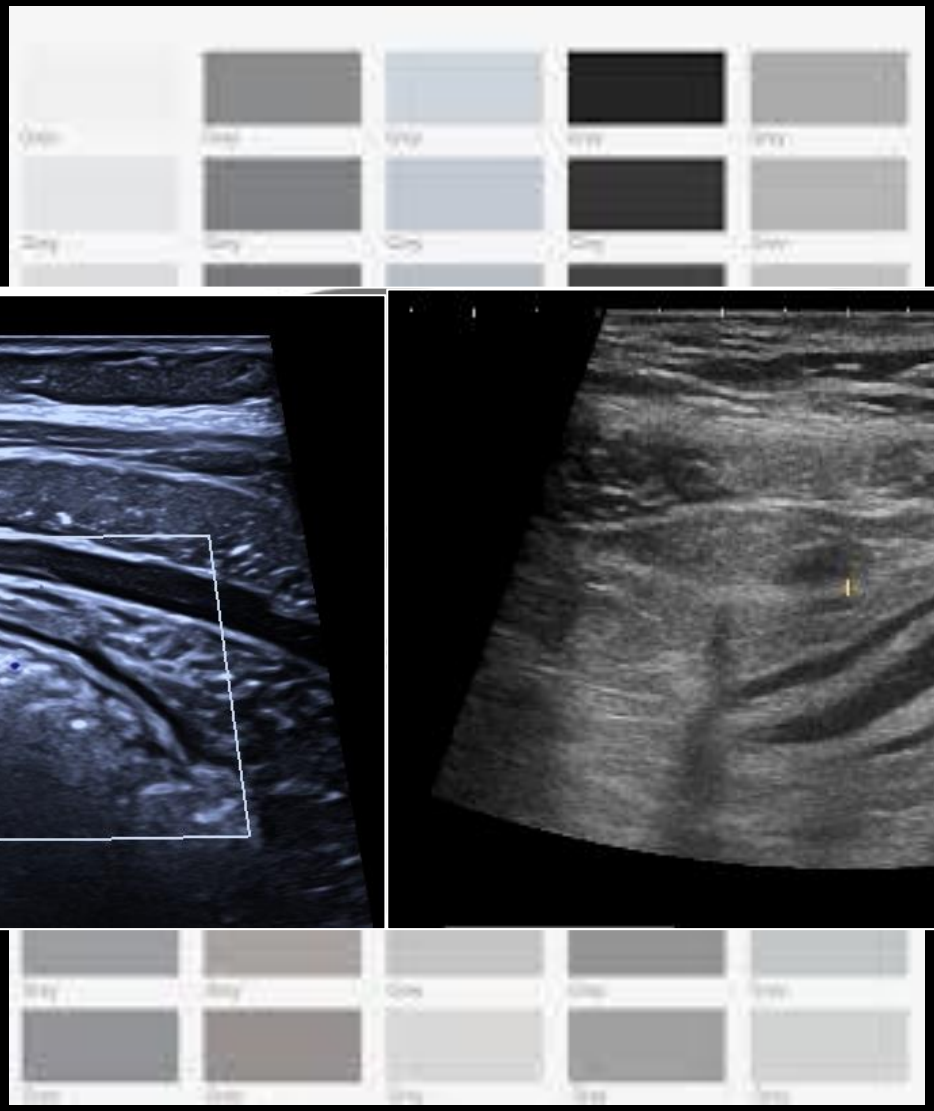
B-mode



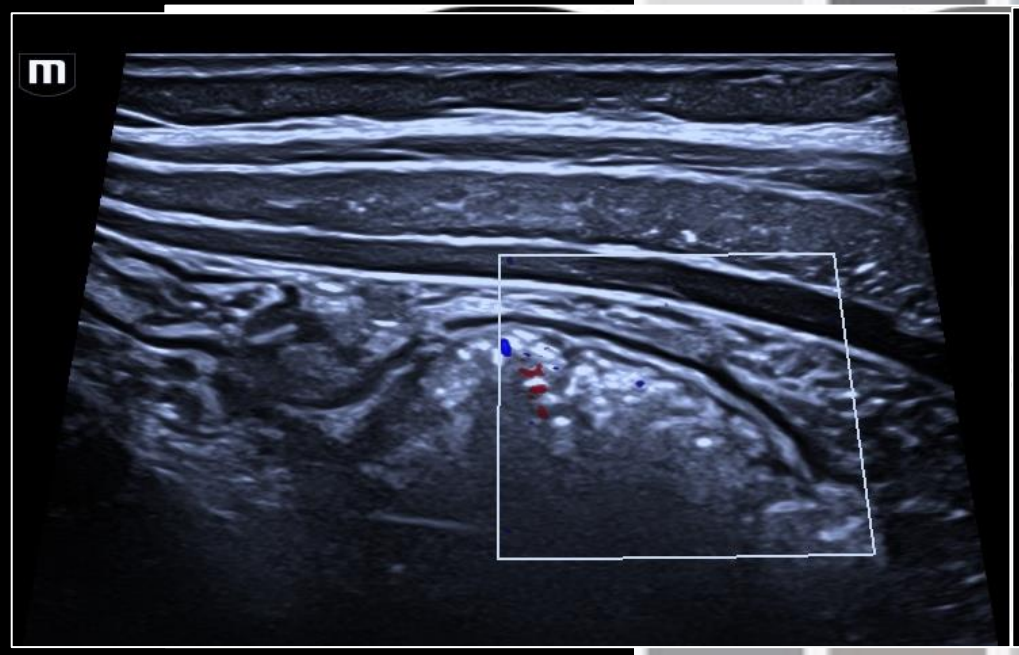


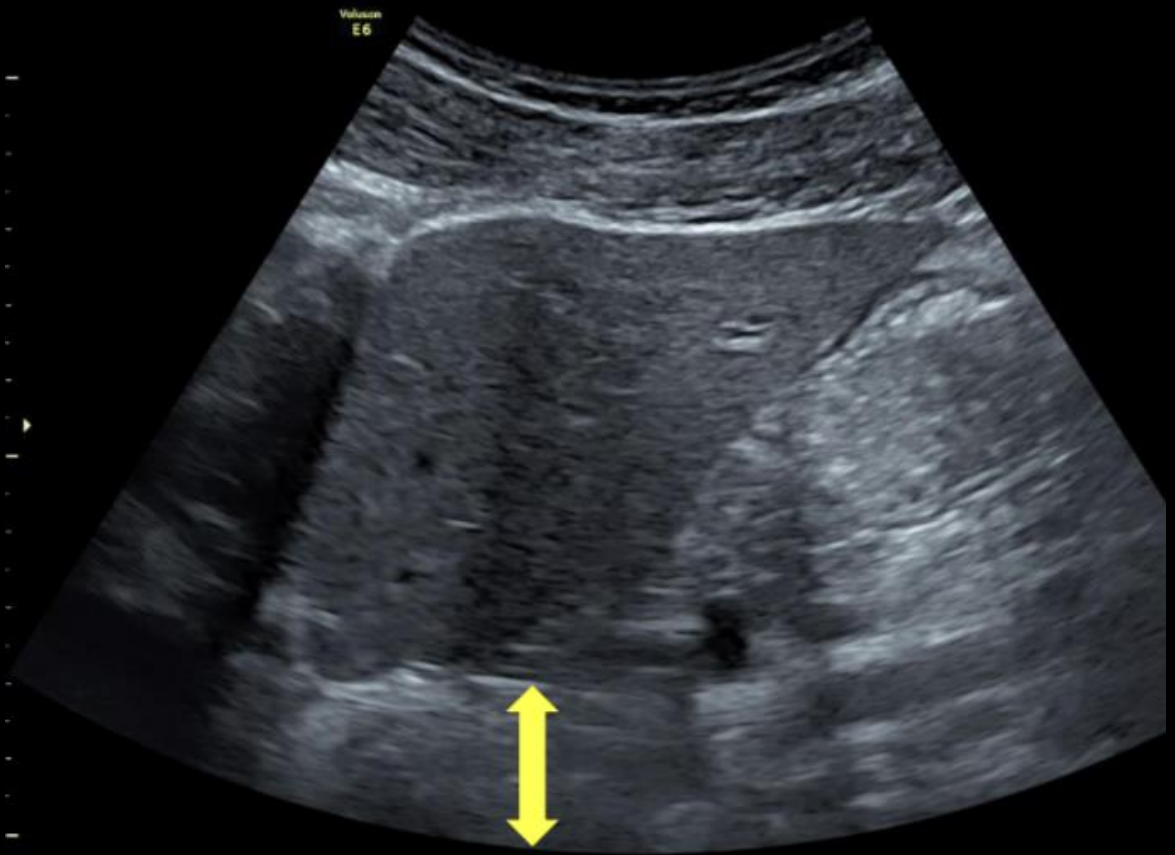
Image optimisation – B Mode

So many buttons! Need to know:

1. Depth dial
2. Gain dial
3. Focus wheel (if not automatic)
4. Freeze image
5. Trackball
6. Store button for still image
7. Store button for cine loops
8. Calipers, image labelling/keyboard

1. Depth

- **Depht: When possible, always choose the lesser depht, adjust to the organ/structure to be examined.**



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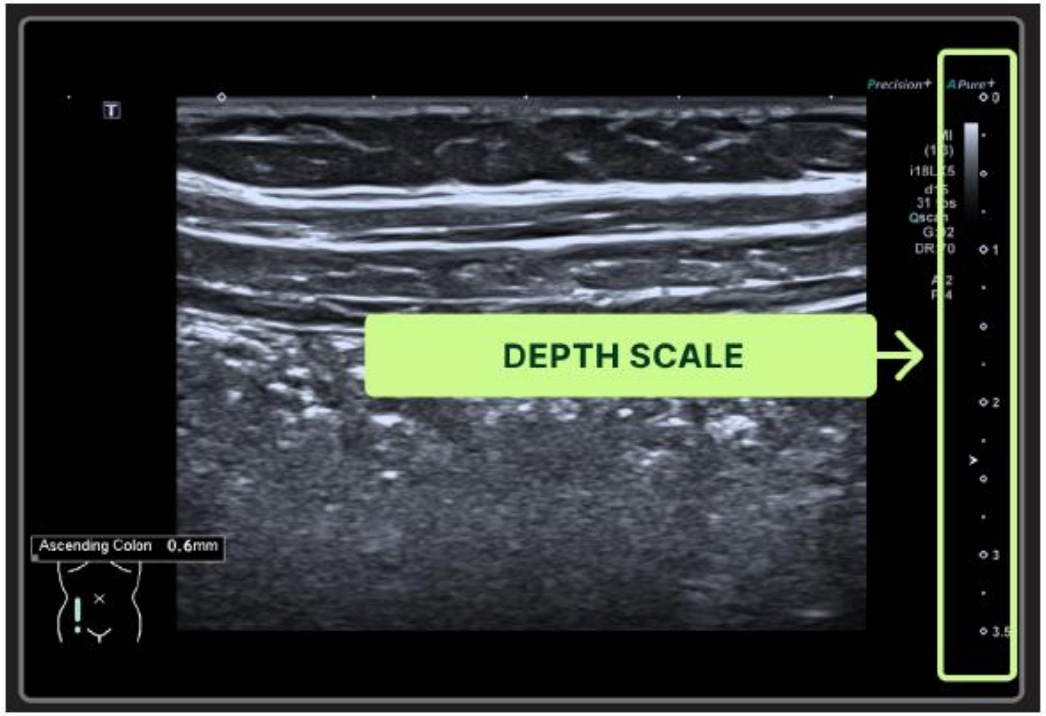
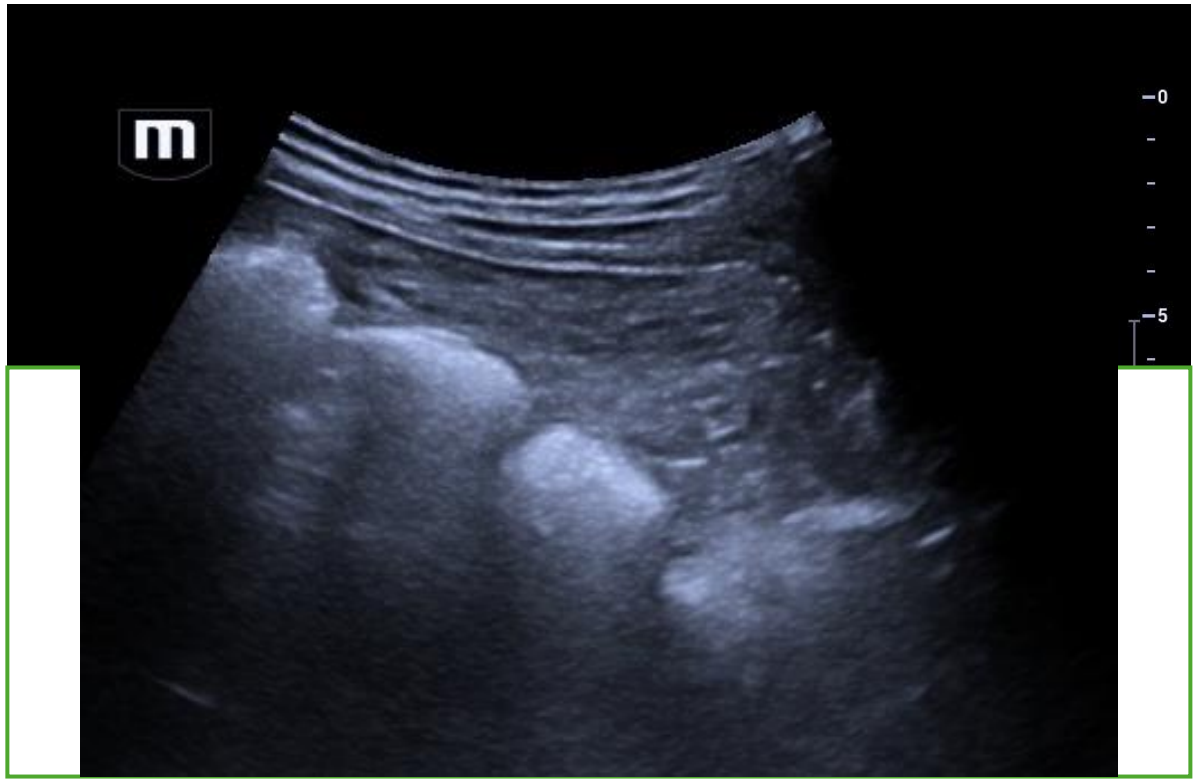
1. Depth





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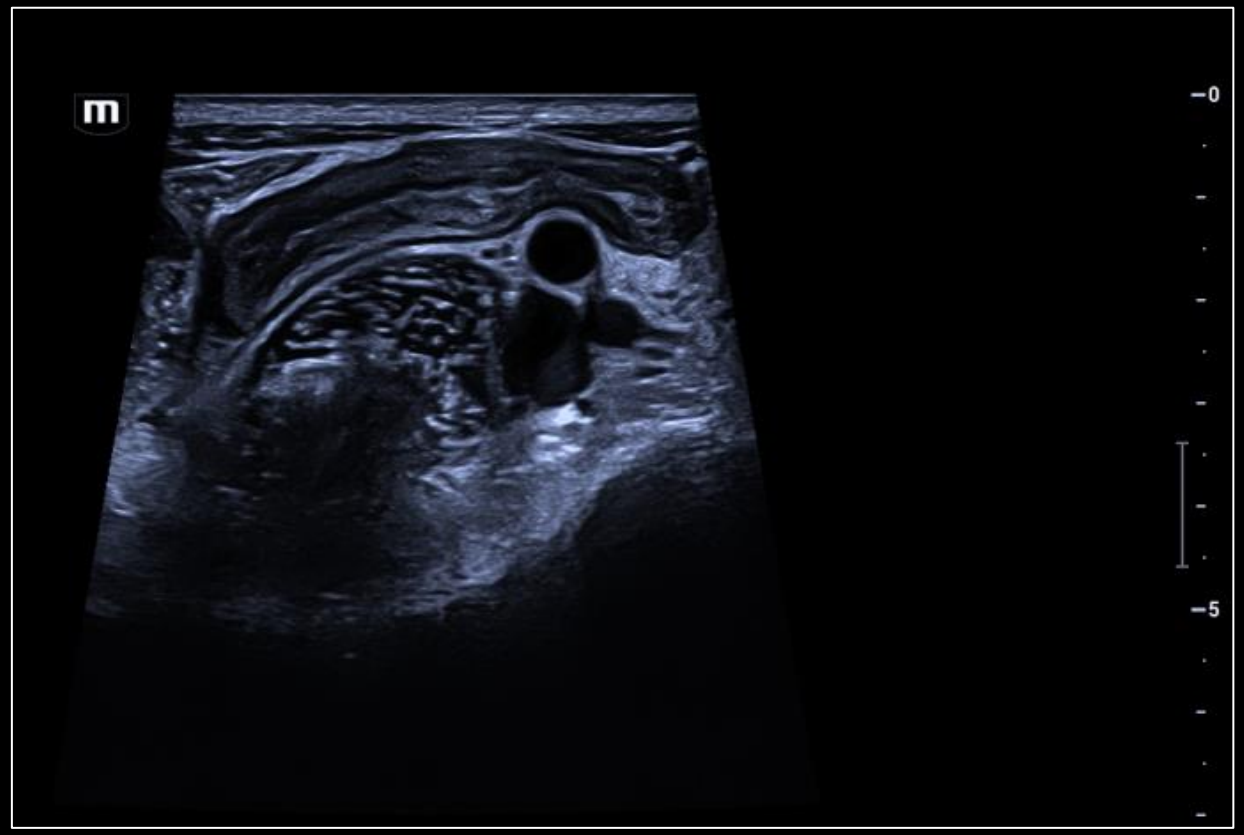
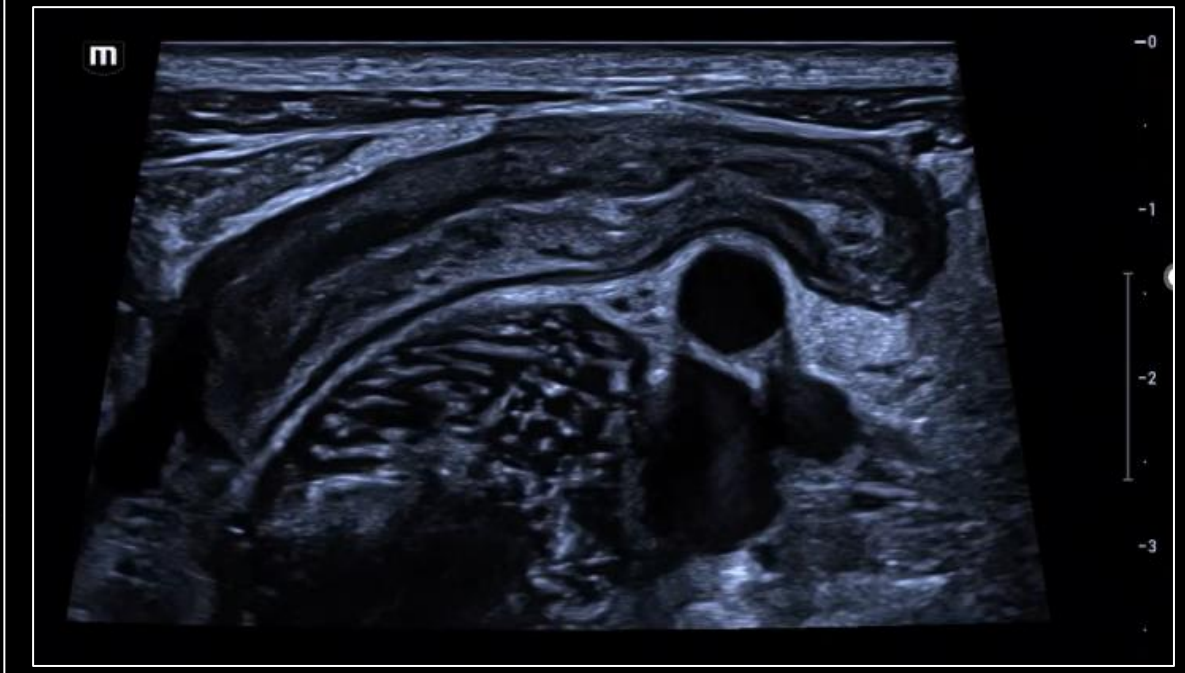
1. Depth





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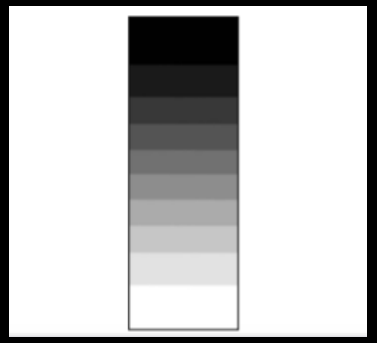
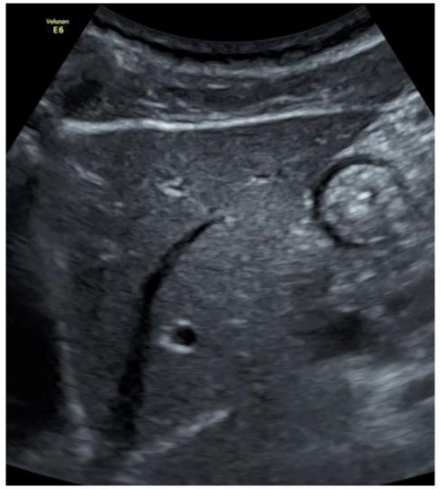
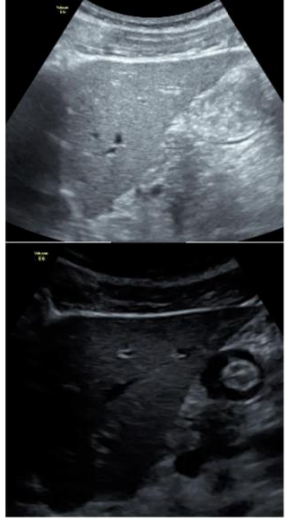
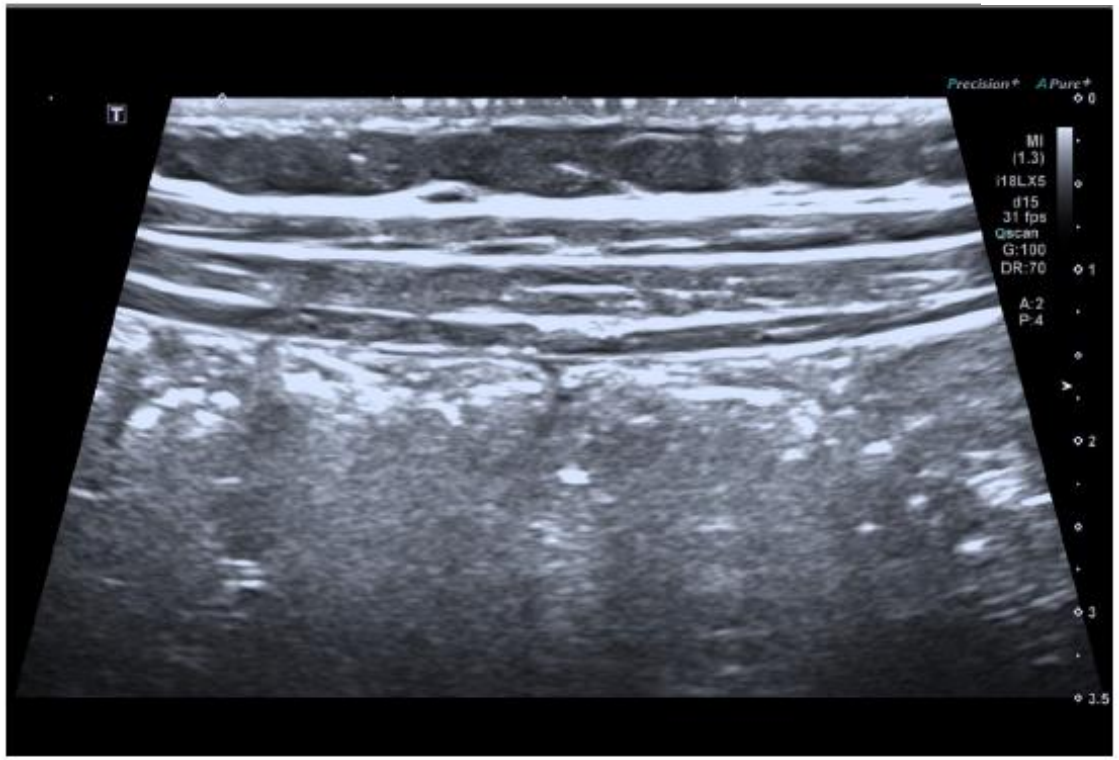
2. Gain

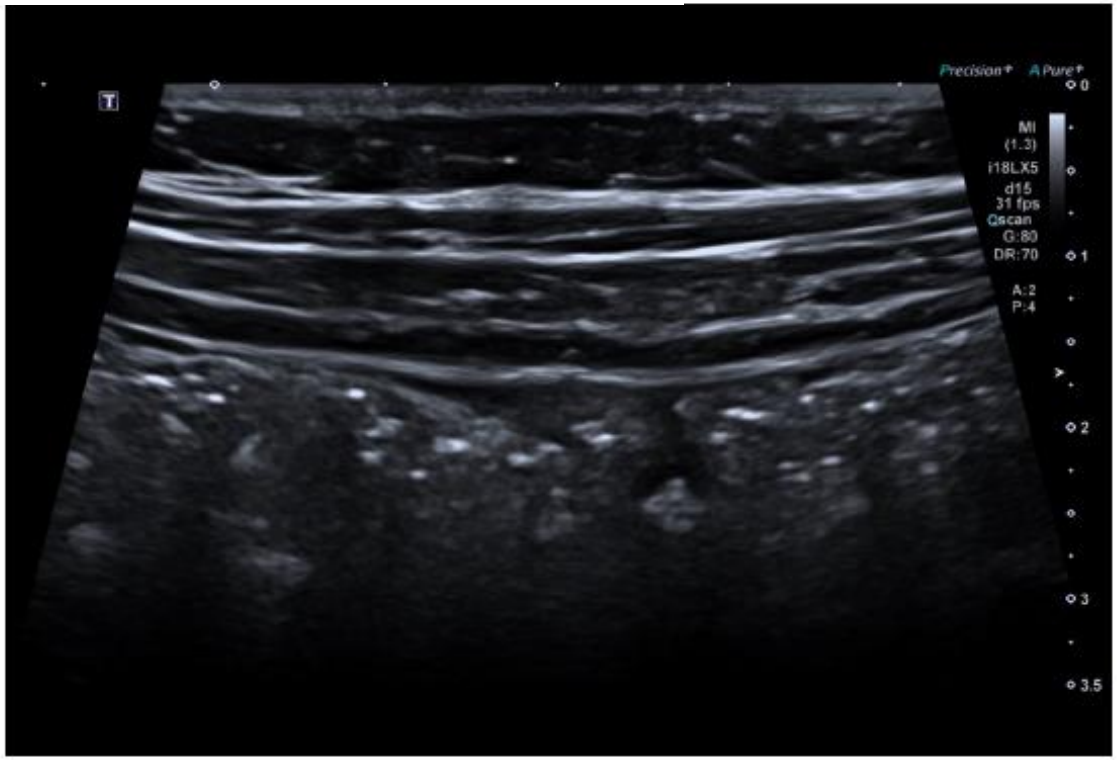






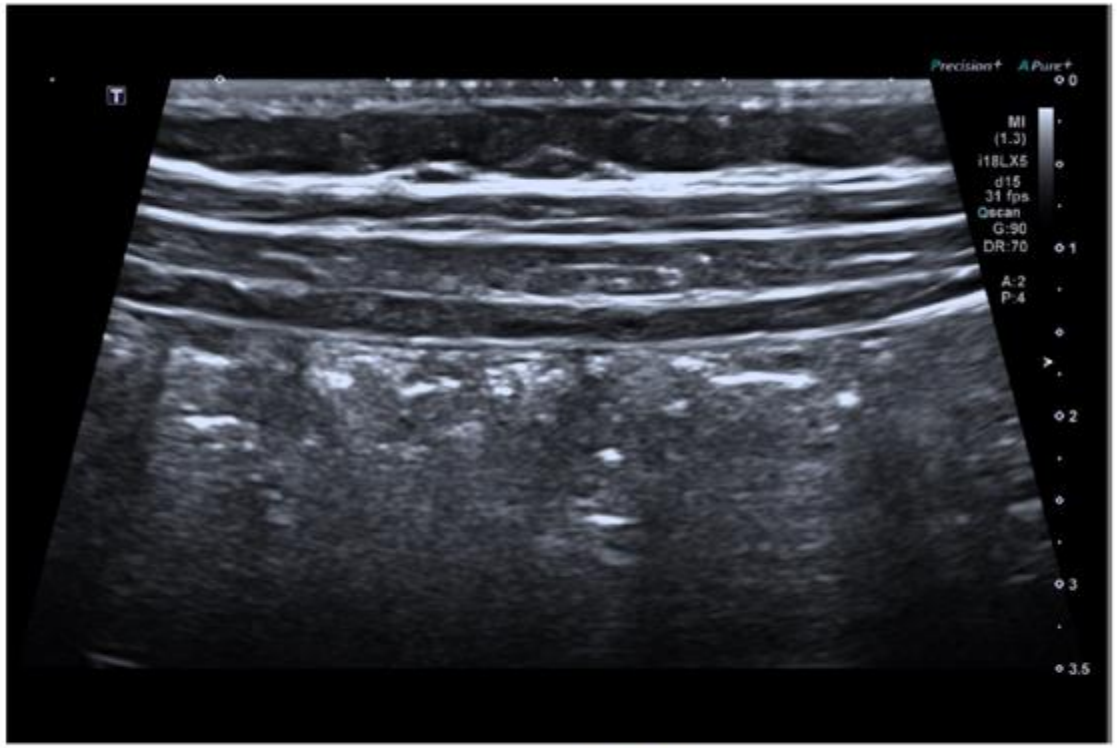


Too high



Too low

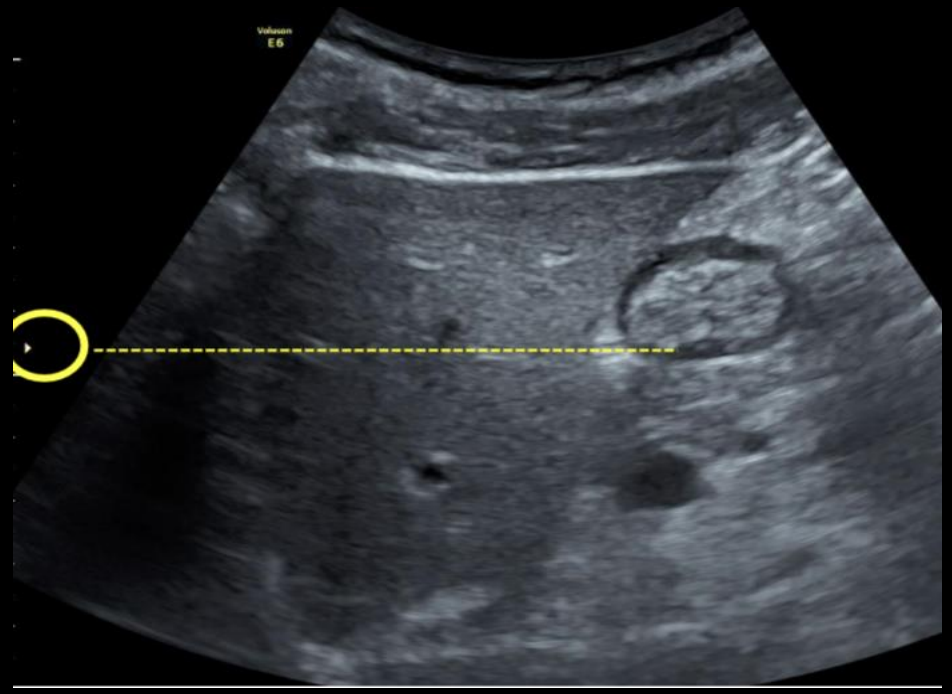
- **Gain – brightness**
  - **Total – spin the B botton**
  - **Setorial – TGC – adjust brightness by tracks**



Just right

3. Focus

- **Focus – use 1 to 2, adjust the structure to be examed to obtain the best sharpness**



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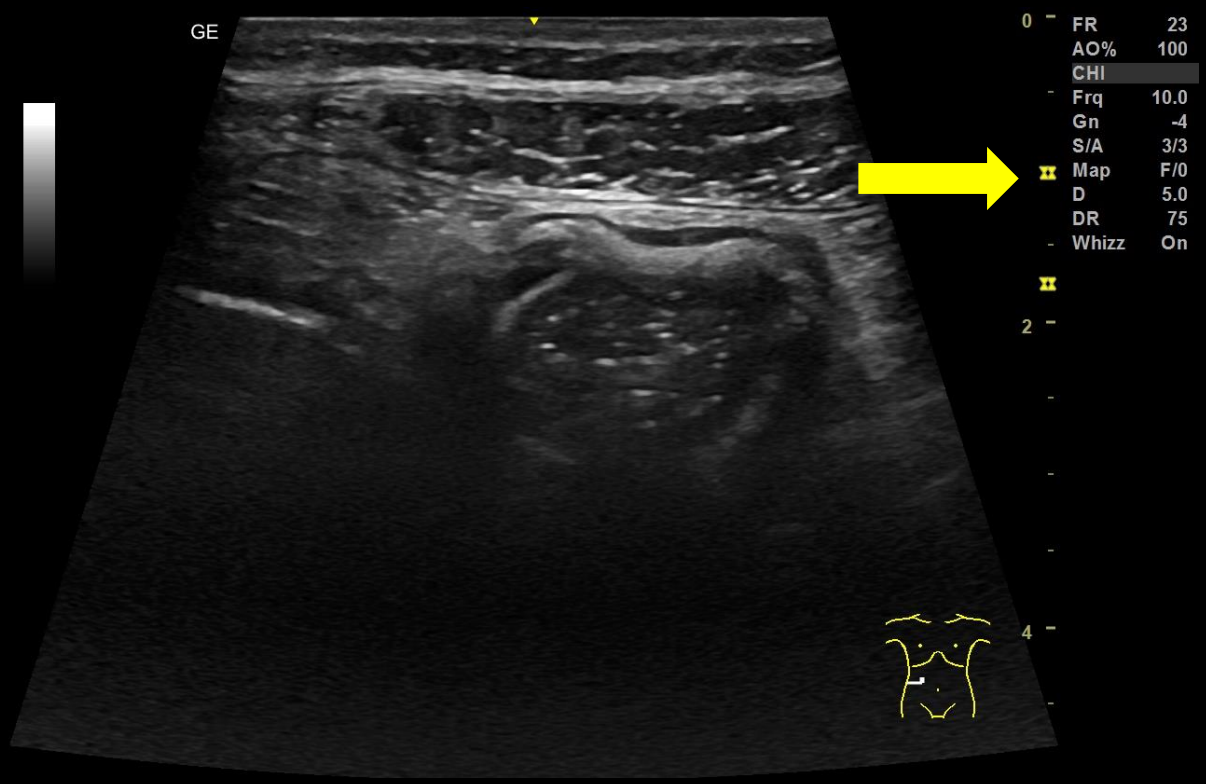
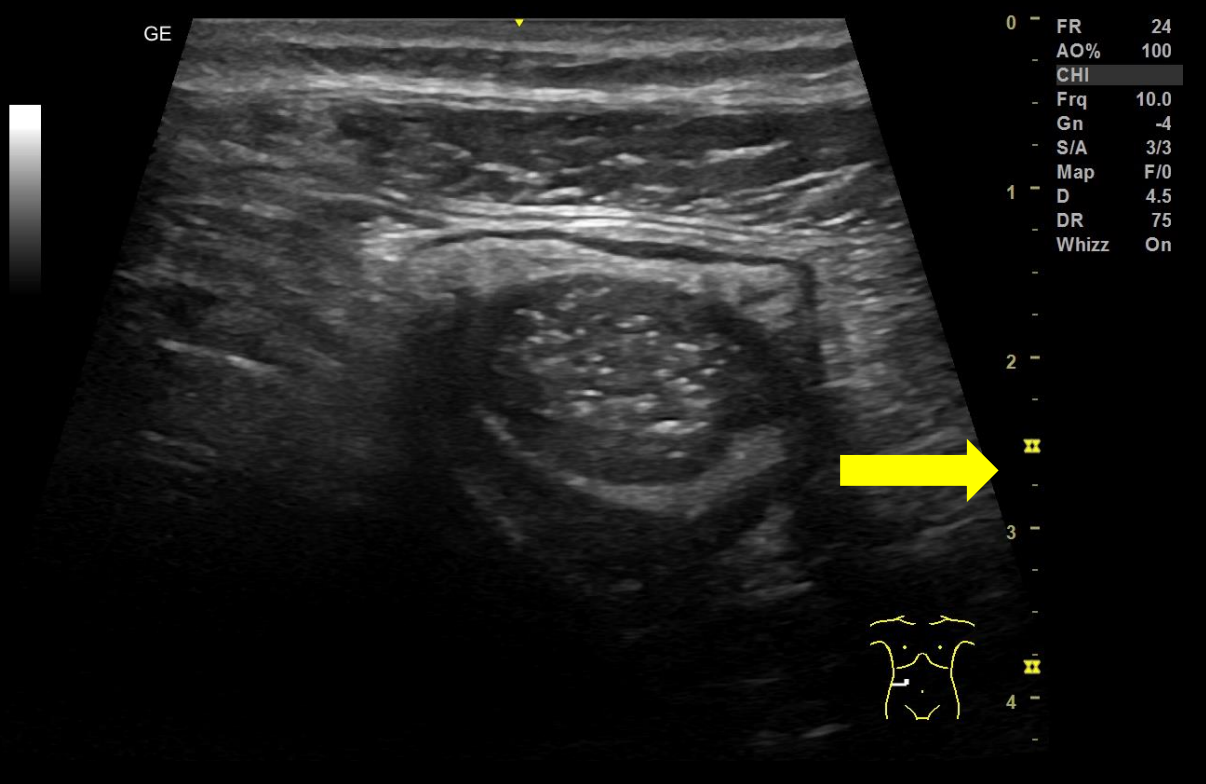
3. Focus





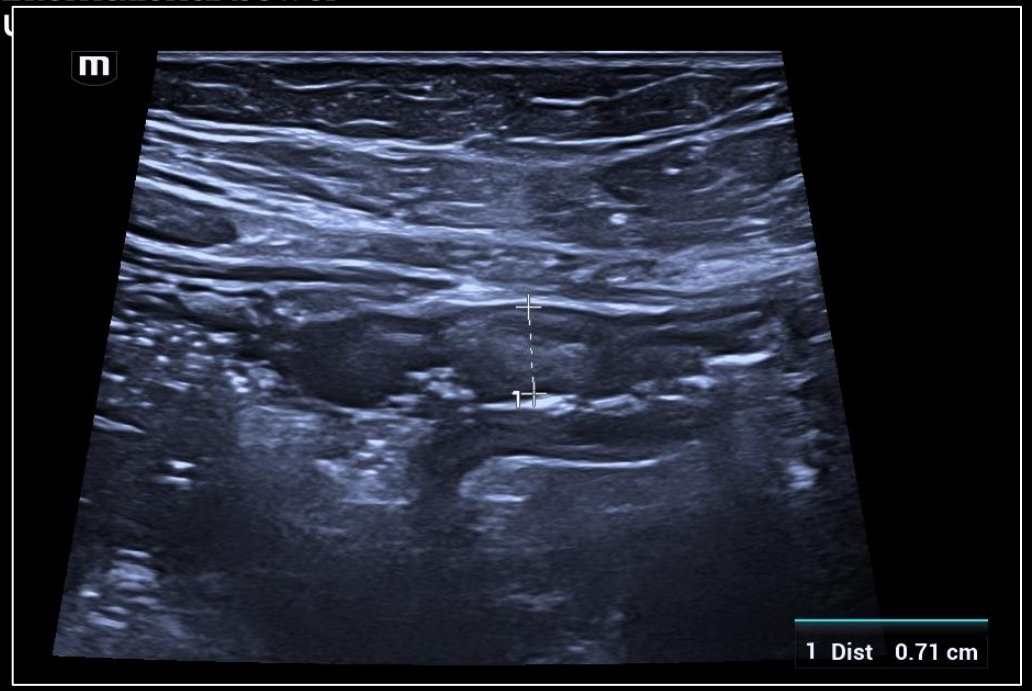
Courtesy of Dr. Marios Katsaros, Hippokration General Hospital

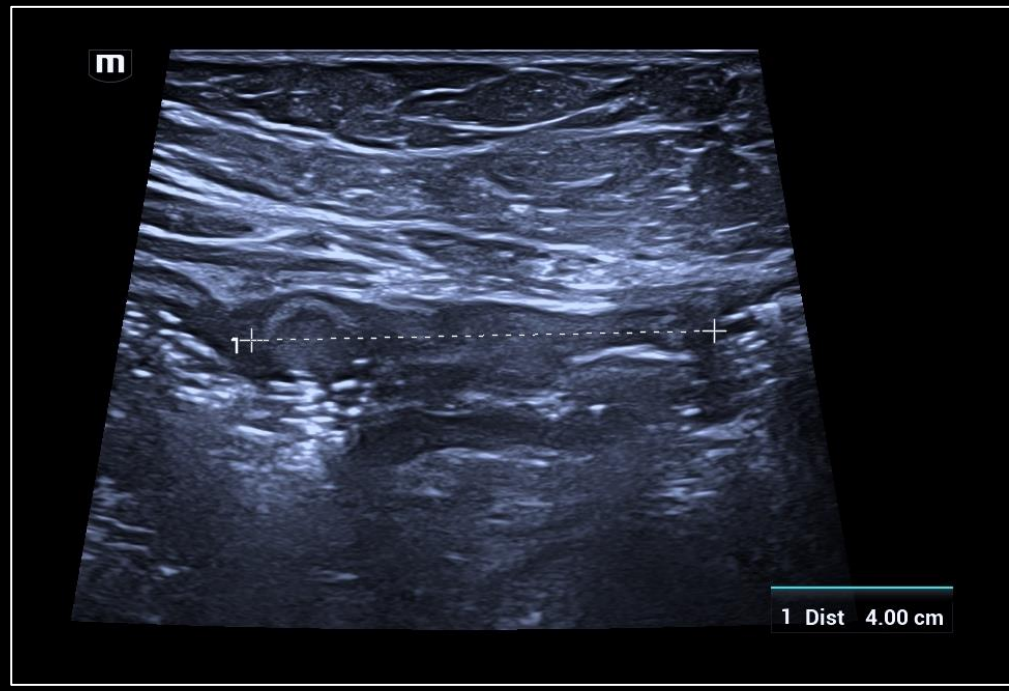
4,5,6 y 7: Freeze, Trackball and Store

- Freeze image on screen
- Use trackball: Scroll back to best frame
- Storage: Save image / cineloop chosen

8. Calipers, image labelling/keyboard

- Bowel wall thickness
- Length of stricture
- Luminal diameter


1
1 Dist 0.71 cm


1
1 Dist 4.00 cm

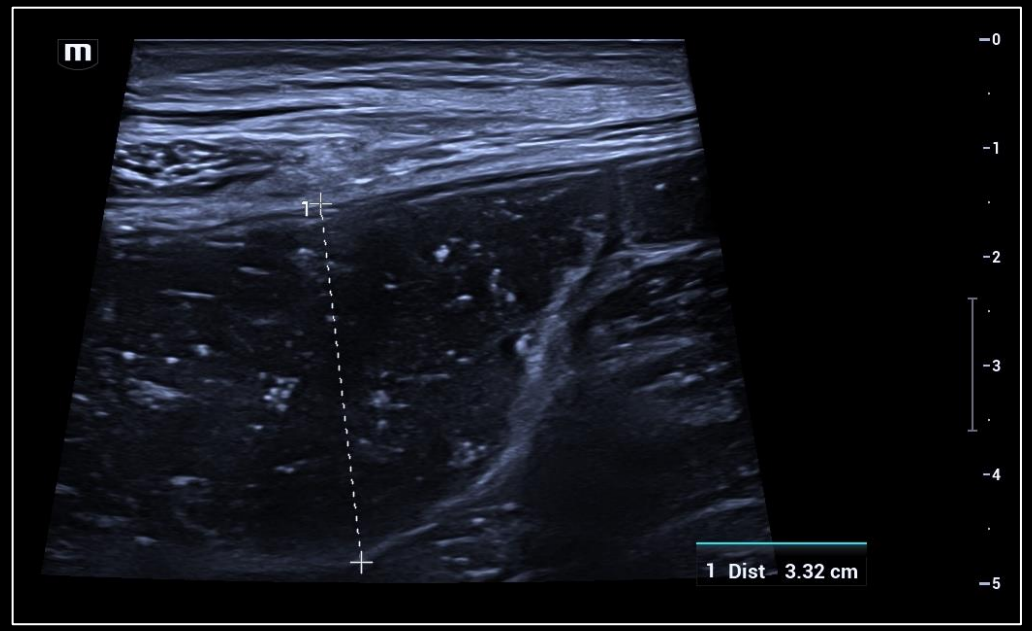

1
1 Dist 3.32 cm
0
1
2
3
4
5

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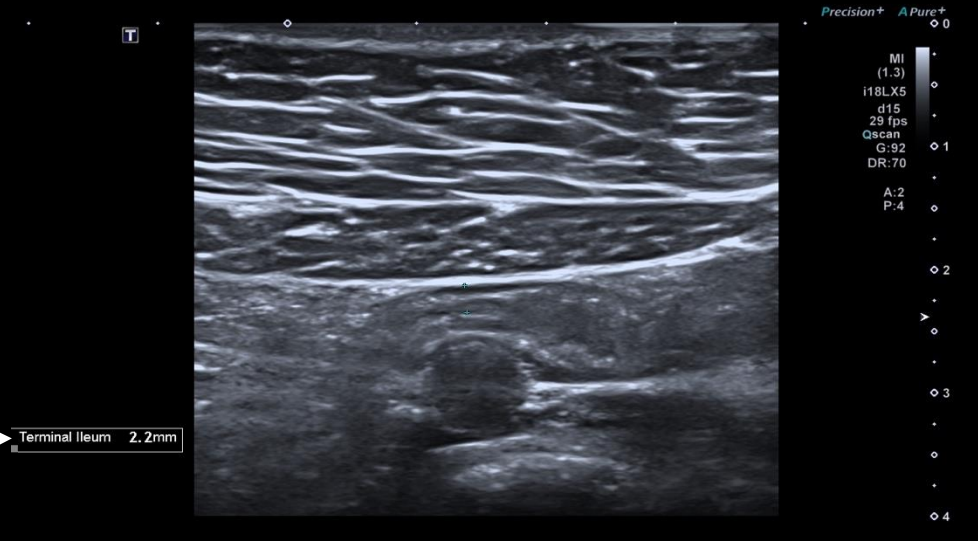
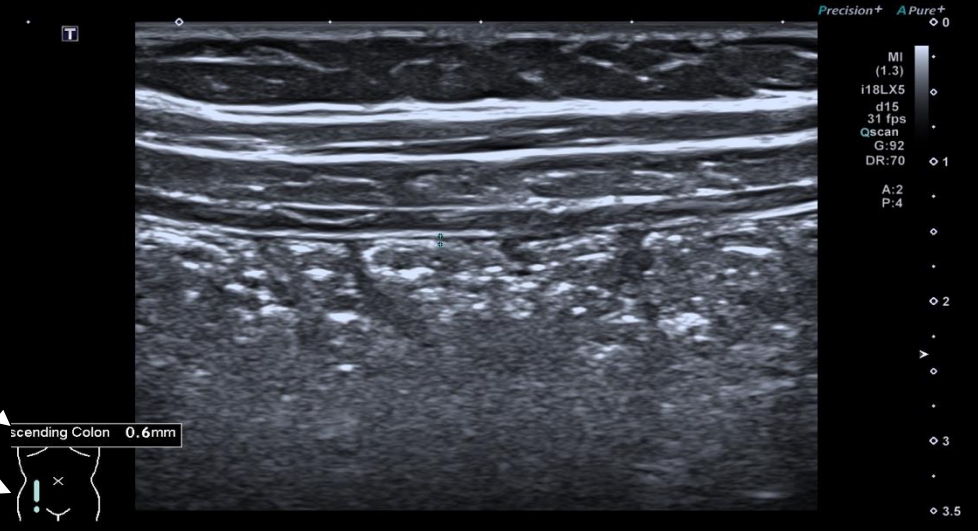
Image labelling

Segment labelling

Body position marker

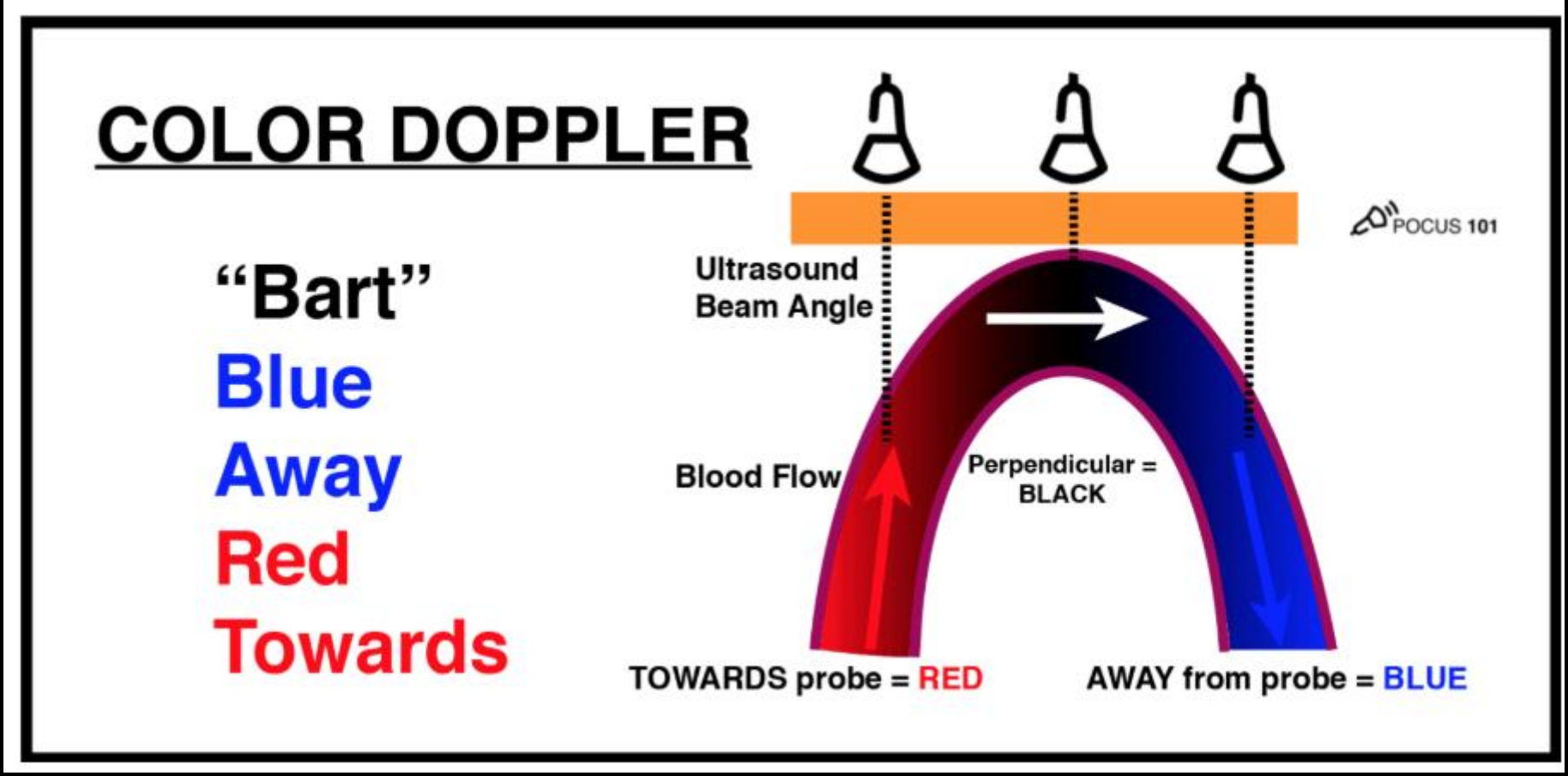
Probe orientation marker





Doppler mode

Presence, direction and speed of flow in a vessel



KEY DOPPLER SETTINGS IN INTESTINAL ULTRASOUND FOR IBD

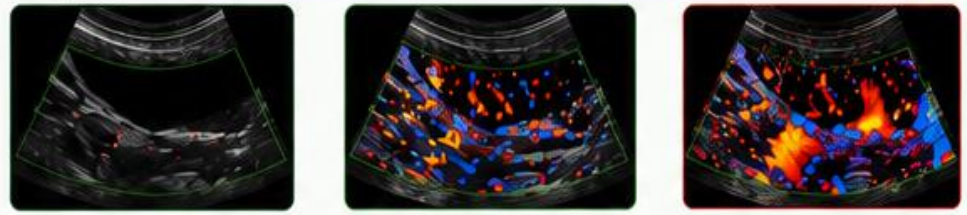
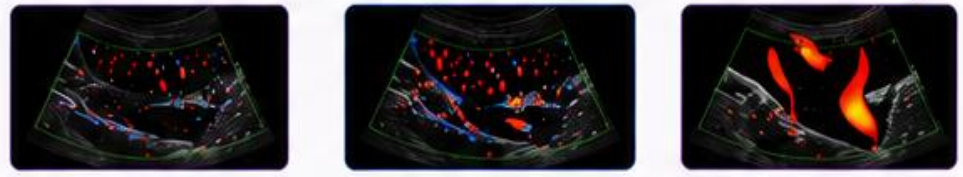
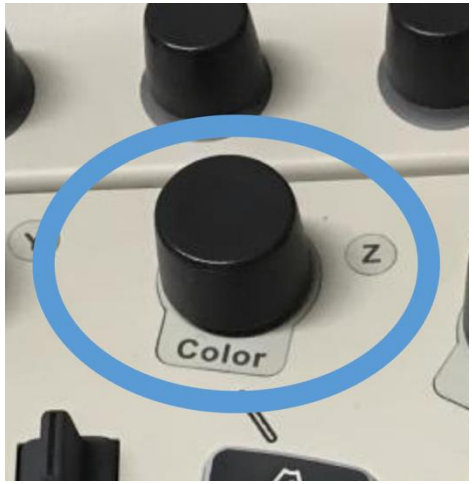
SETTING	WHAT DOES IT MODIFY?	WHAT YOU SEE ON THE SCREEN	ANALOGY
B-mode Gain	The brightness of the image in grayscale. Increases or decreases the amplification of echoes returning to the transducer.	Too low → Optimal → Too high  Too low: Image too dark, loss of details Optimal: Balanced image, best contrast Too high: Image too bright, loss of contrast	THE BRIGHTNESS OF A PHOTOGRAPH 
Color Gain	The intensity of the Doppler signal (color). Adjusts the sensitivity to detect blood flow.	Too low ← Optimal → Too high  Too low: Little or no color, may look like there is no vascularization Optimal: Appropriate amount of color, best evaluation Too high: Too much color, noisy image	THE VOLUME OR SENSITIVITY OF THE COLOR  Low → High
PRF (Pulse Repetition Frequency)	The range of flow velocities that Doppler can detect. Determines the sensitivity of Doppler for slow or fast flows.	Low PRF → Optimal PRF → High PRF  Low PRF: Detects slow flows (more sensitive) Optimal PRF: Better balance High PRF: Detects only fast flows, may miss small vessels	THE SENSITIVITY OF A MICROPHONE  Very sensitive → Less sensitive

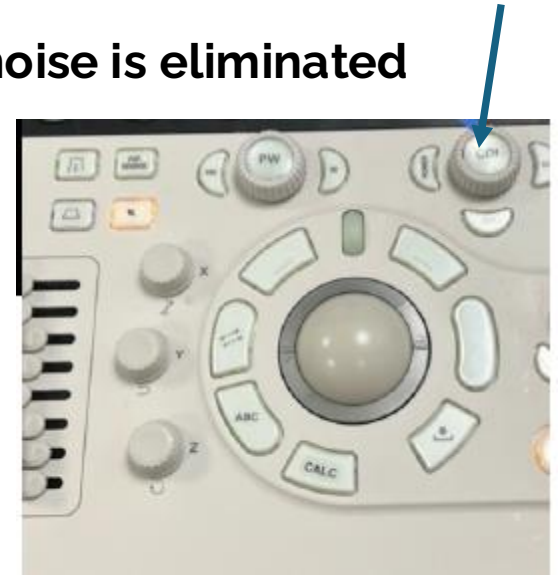
Image optimisation – Colour Doppler



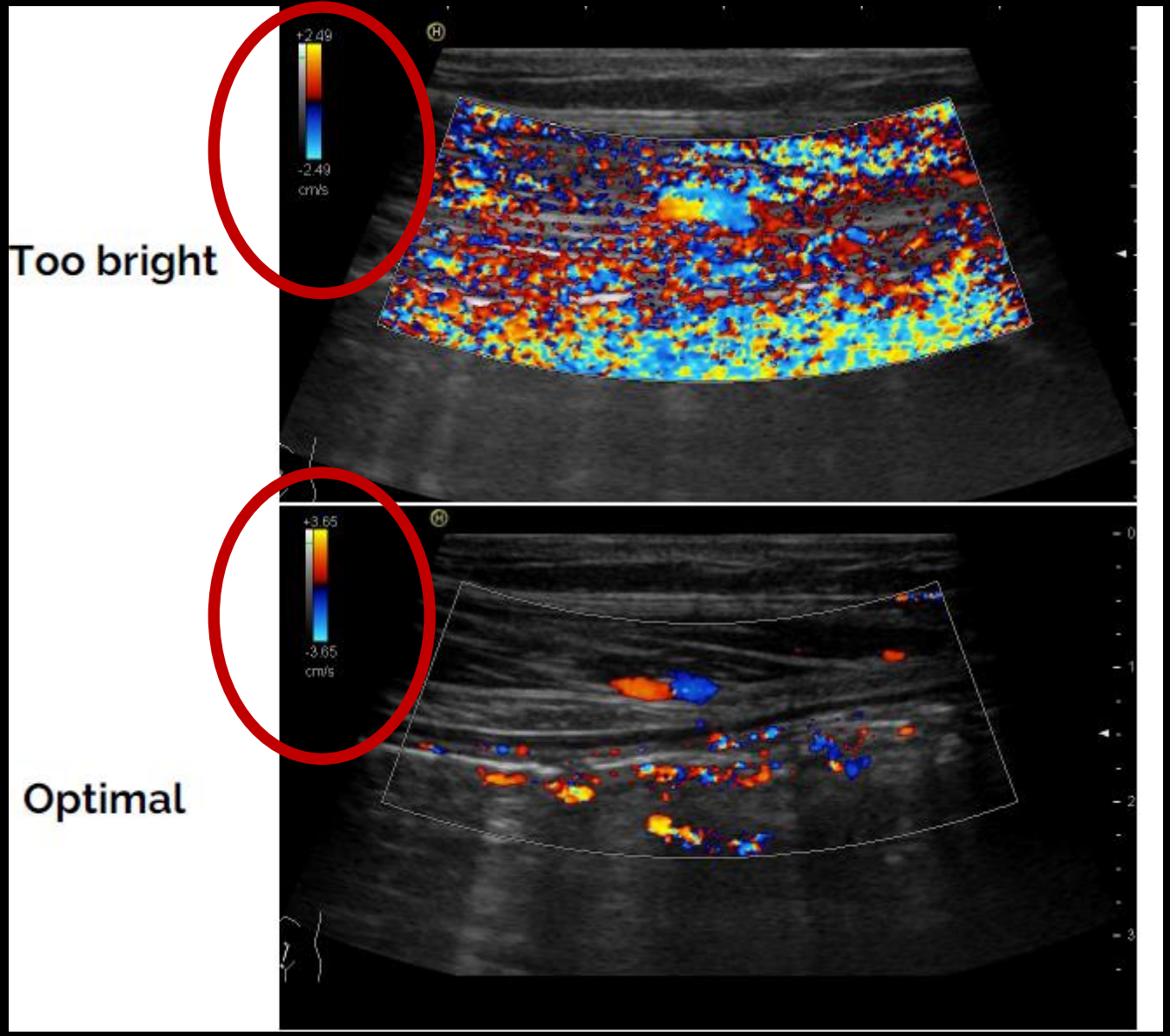
- Optimize the colour Doppler for bowel wall interrogation

- **Velocity range : 5-7cm/s optimal**
  - **Velocity range is Pulse repetition frequency in some brands**

- **Reduce velocity to the lowest point where a signal is detected but noise is eliminated**



- Optimise the gain (brightness)


Too bright
+2.49
-2.49
cm/s
Optimal
+3.65
-3.65
cm/s

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HOW TO OPTIMIZE COLOR DOPPLER IN IUS

Different names, same concept

Depending on the manufacturer	Look for:
Canon / Samsung	Velocity
GE / Mindray	PRF
Philips	Scale

Velocity = PRF = Scale
All adjust the Doppler velocity range (sensitivity).

Optimize Doppler in 2 simple steps

STEP 1	STEP 2
Adjust PRF / Velocity / Scale	Adjust Color Gain
Lower it to detect slow bowel wall flow	Increase until background noise appears, then reduce slightly
✓ Target: 5–7 cm/s	✓ Maximum sensitivity without noise

Remember

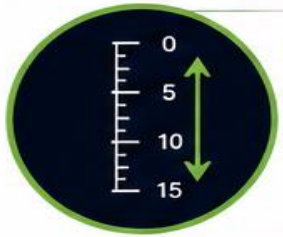
- **PRF decides *WHAT* flow you can detect.**
- **Color Gain decides *HOW MUCH* of that flow you can see.**

TIPS TO OPTIMIZE INTESTINAL ULTRASOUND IMAGING IN IBD

Better settings → Better images → Better decisions

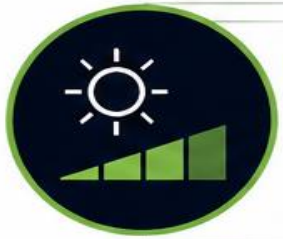
1 CHOOSE THE RIGHT PROBE

Start with a convex probe for overview. Use a linear probe for detail.



2 OPTIMIZE DEPTH

Adjust depth to include the bowel and the area of interest, but not unnecessarily deep.

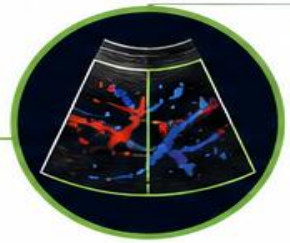


3 ADJUST GAIN

Increase until the image begins to get noisy, then slightly reduce.

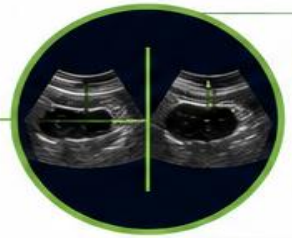
4 POSITION THE FOCUS

Place the focal zone at or just below the level of the bowel wall.



5 USE DOPPLER WISELY

Use Color or Power Doppler to assess vascularity. Adjust Color Gain and PRF to detect low-velocity flow without noise.



6 SCAN IN TWO PLANES

Evaluate the bowel in both longitudinal and transverse planes.

7 APPLY GRADED COMPRESSION

Use gentle, graded compression to displace gas and improve contact.

8 CORRELATE WITH THE CLINICAL QUESTION

Always tailor your scan and optimize based on the clinical scenario.

Good images are not obtained by chance—they are created through **systematic optimization**.

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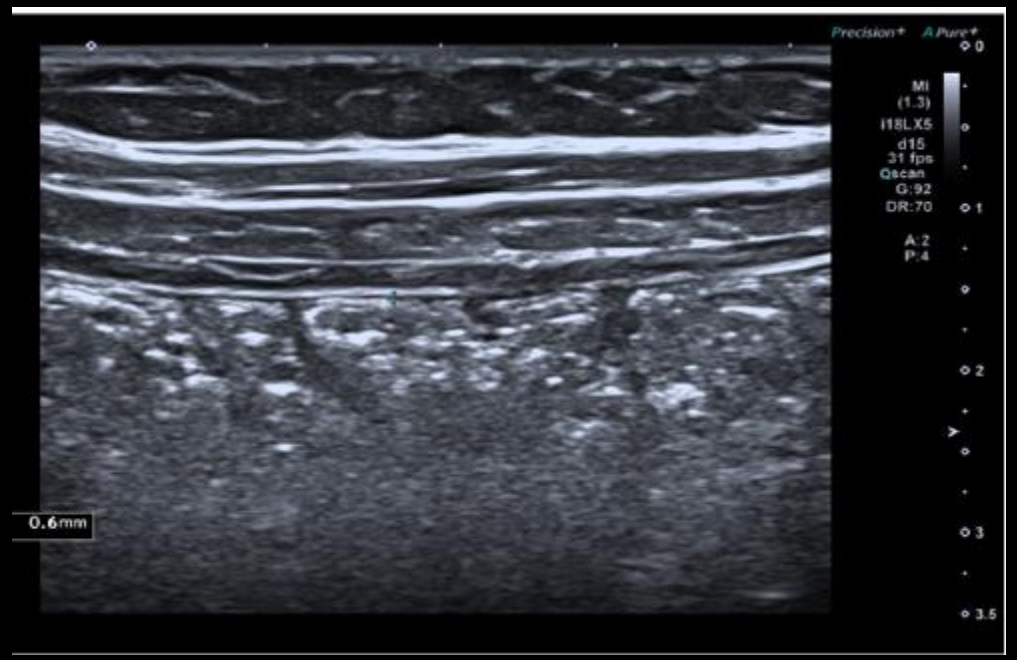
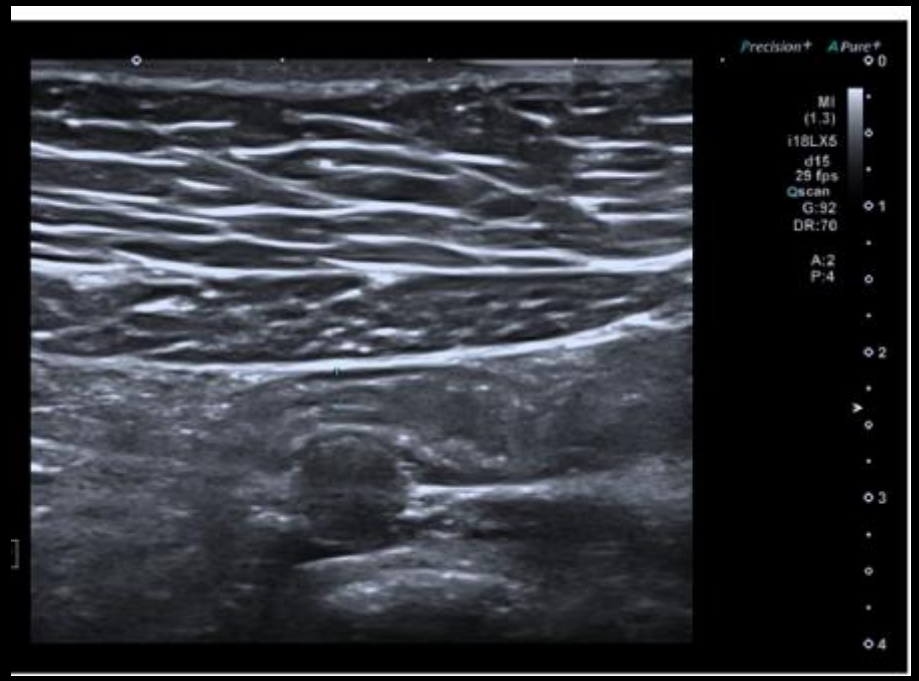
Optimal images



Depth
Gain
Focus ✓



Anything Missing ?

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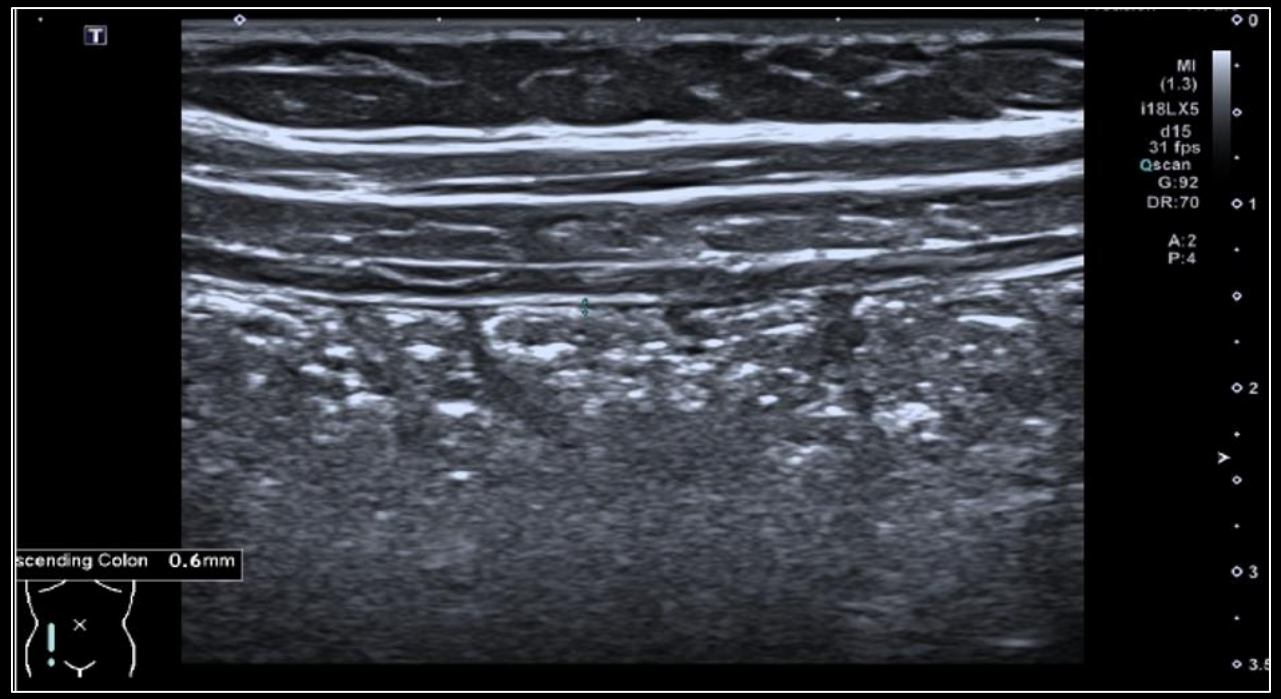
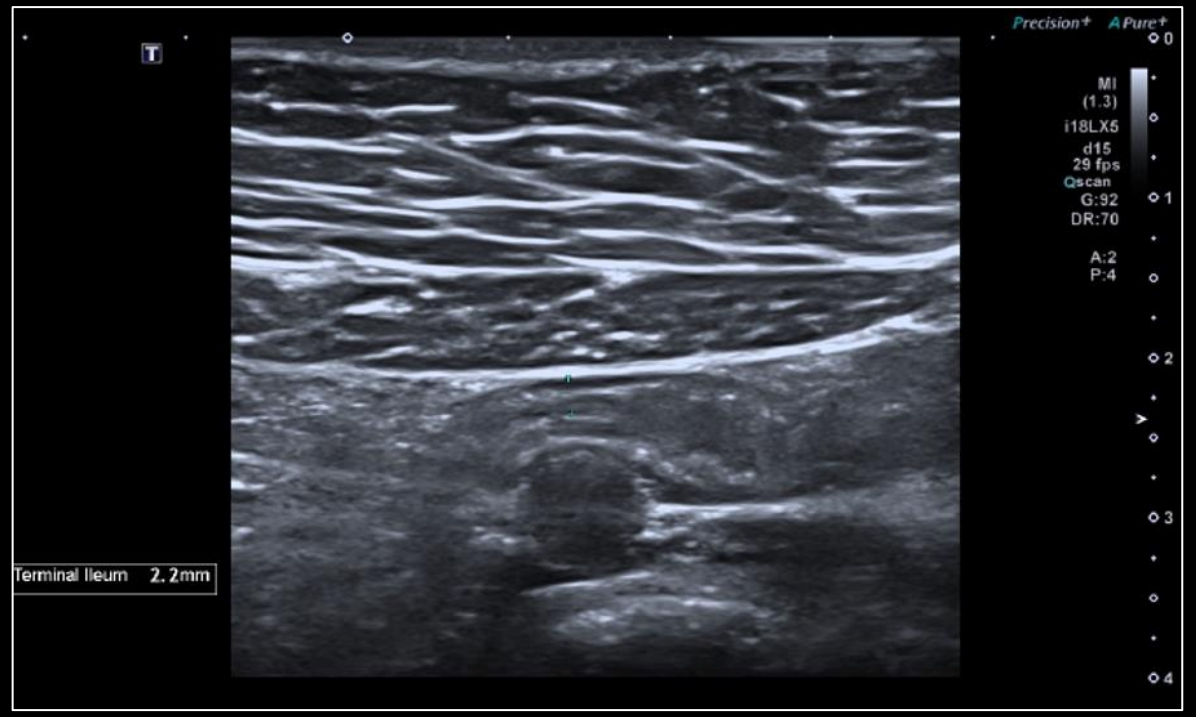
Optimal images





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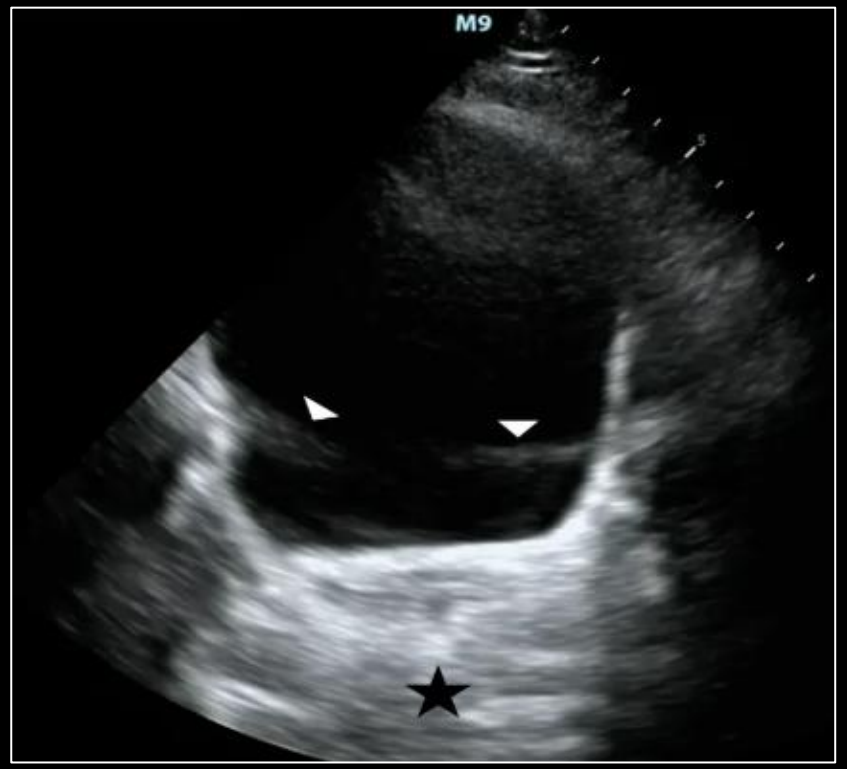
Artifacts...

Shadowing



Post acoustic enhancement

Reverbation

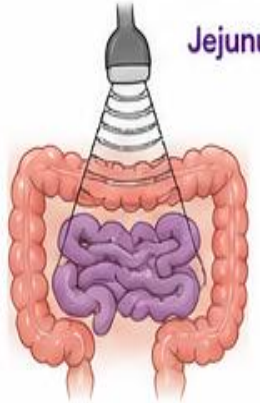
KNOW THE LIMITATIONS OF IUS

IUS is an excellent tool, but it has limitations. → Know when to complement with other imaging.

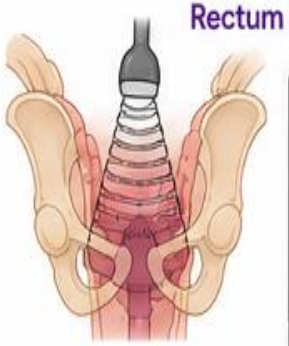
1 DEEP OR PROXIMAL DISEASE

Lower performance in the proximal small bowel (jejunum) and in deep pelvic areas (rectum).

Jejunum (deep)



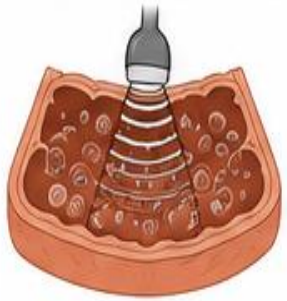
Rectum (deep pelvis)



2 PHYSICAL INTERFERENCE

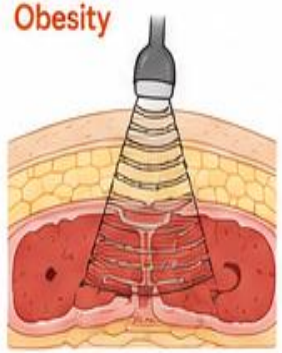
Abundant intestinal gas or patient obesity limit the acoustic window.

Abundant intestinal gas



Gas artifacts (shadowing, reverberation)

Obesity

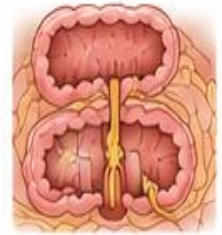


Poor penetration, deep image quality

3 COMPLEX COMPLICATIONS DIFFICULT TO DELIMIT ?

Difficult to clearly delineate deep fistulas, complex tracts or abscesses hidden behind inflamed bowel loops.

Deep fistulas



Tract not completely visible

Complex tracts

Difficult to follow the complete tract

Occult abscesses

Behind inflamed loops, may not be seen

4 OPERATOR DEPENDENT

The quality of the study depends on the operator's experience and knowledge in IUS.

- Steep learning curve.
- Interobserver variability.
- Experience impacts detection and characterization of disease.

KEY TAKE HOME MESSAGES

1 KNOW YOUR MACHINE BEFORE SCANNING YOUR PATIENT

Understand your ultrasound system, probes and presets.

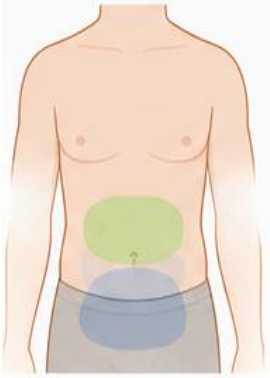
SYSTEM

PROBES

PRESETS

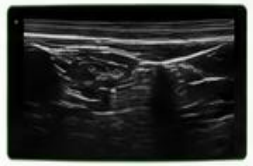
2 CHOOSE THE RIGHT PROBE FOR THE RIGHT CLINICAL QUESTION

Start broad, then focus on detail.



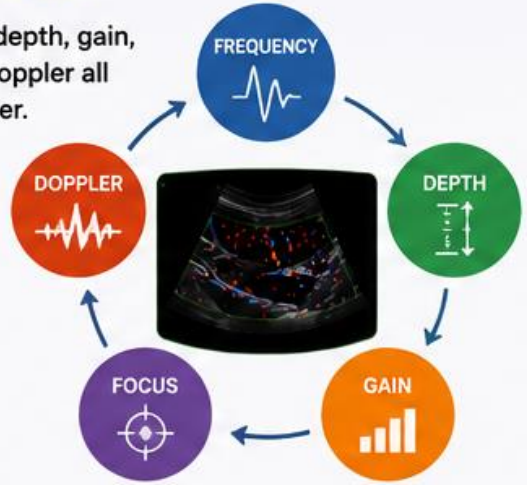
CONVEX
Broad view, deeper penetration

LINEAR
High resolution, superficial detail



3 PHYSICS EXPLAINS IMAGE QUALITY

Frequency, depth, gain, focus and Doppler all work together.



4 OPTIMIZE BEFORE YOU INTERPRET

Adjust depth → focus → gain → Color Doppler (PRF/Velocity + Gain).

5 RECOGNIZE ARTEFACTS AND KNOW THE LIMITATIONS

Gas, obesity, deep bowel segments and complex disease may require complementary imaging.

6 GOOD IMAGES LEAD TO BETTER CLINICAL DECISIONS

Image optimization is the foundation of accurate IUS.

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"Better settings → Better images → Better decisions."

Thank you!

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ARTÍCULO DE REVISIÓN

Ultrasonido intestinal en la Enfermedad Inflamatoria Intestinal: ¿cuándo utilizarlo y cómo aplicarlo eficazmente?

Intestinal ultrasound in inflammatory bowel disease: When and how use it efficiently?

Viviana Parra Izquierdo[1,2,3], Hugo Cedron[4], Marjorie Argollo[5], Joana Torres[6,7,8], Kenneth Ernest-Suárez[9]

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