
بسم الله الرحمن الرحیم


وفوق کل ذی علم علیم

في اطار بروتوكول التعاون بين كلية الطب البيطري جامعة بنها ونقابة الاطباء البيطرين

دورة تحت عنوان


# Basic principles and Applications of Ultrasonography in Farm Animals

## Trainer


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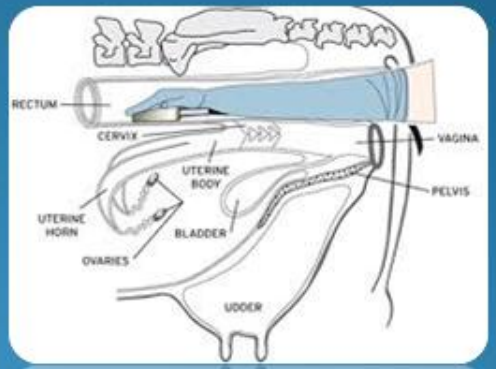
# Basic principles and Applications of Ultrasonography in Farm Animals

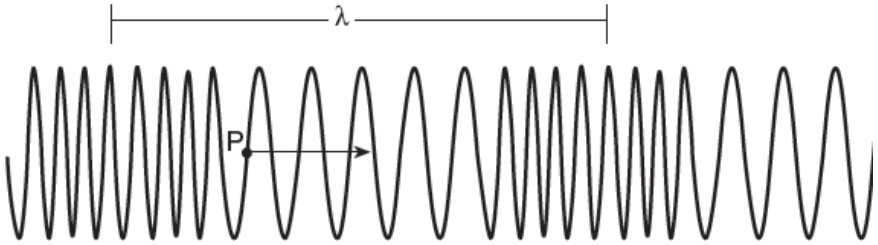

# Who uses ultrasound technology?

- Small animal veterinarians
- Large animal veterinarians
- Mixed animal veterinarians

- **Ultrasound machine with various transducer probes**

# Ultrasound Physics

- **Sound** is a mechanical, longitudinal wave that travels in a straight line
- **Sound** requires a medium through which to travel
- **Ultrasound** is a mechanical, longitudinal wave of compressions and rarefication within a medium



- **Ultrasound** is a very high frequency sound exceeding the upper limit of human hearing, which is 20,000 Hz or 20 kHz.
- Frequency is the number of cycles per second
- speed is the distance travelled in a particular time, usually one second

$$v = f \times \lambda \quad > \quad f \propto 1/\lambda$$

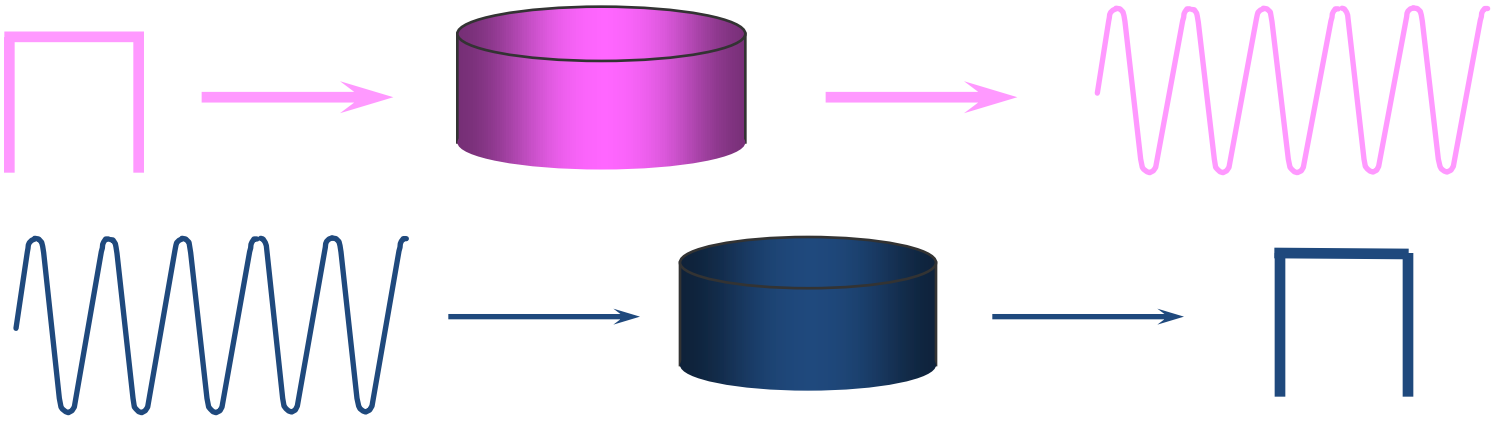
$v$ = velocity  f = frequency  $\lambda$ = wavelength

| | | |
|---|---|---|
| 1 cycle/second | = | 1 Hz |
| 1000 cycles/second | = | 1 KHz |
| 1 000 000 cycles/second | = | 1 MHz |

# Ultrasound Production

- Transducer produces ultrasound pulses (transmit 1% of the time)
- These elements convert electrical energy into a mechanical ultrasound wave

- Reflected echoes return to the scanhead which converts the ultrasound wave into an electrical signal

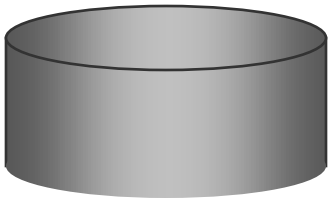


# Piezoelectric effect

- Ultrasongraphy is based on the pulse-echo principle
- Electric --- wave---- production of different echoes
- The ultrasound scanner converts this information into dots of light on the screen.
- The position of the dots of light on the screen is proportional to the actual distance travelled

# Frequency vs. Resolution

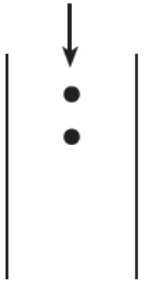
- The frequency also affects the QUALITY of the ultrasound image
  - The **HIGHER** the frequency, the **BETTER** the resolution
- The **LOWER** the frequency, the **LESS** the resolution
- A 12 MHz transducer has very good resolution, but cannot penetrate very deep into the body
- A 3 MHz transducer can penetrate deep into the body, but the resolution is not as good as the 12 MHz



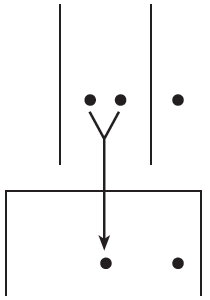
Low Frequency
3 MHz

High Frequency
12 MHz

- **Axial resolution**
- Axial resolution is the ability to differentiate two points along the length of the ultrasound beam



- **Lateral resolution**
- Lateral resolution is the ability to differentiate two points lying side by side perpendicular to the ultrasound beam.



# Frequency

Better penetration



3.5 MHz | 5 MHz | 7.5 MHz | 10 MHz



Higher resolution

| Frequency (MHz) | Depth (cm) |
|---|---|
| 5.0 | 12–15 |
| 7.5 | 6–8 |
| 10 | 4 |

# Transducer selection guidelines

- • **7.0 MHz or higher**: cat abdomens, small dog abdomens, ocular, tendons
- • **5.0 MHz**: medium to large dog abdomens, most hearts (especially if Doppler capabilities are needed)
- • **2.0-3.0 MHz**: large animal abdomens, heart

# Uses of ultrasound

- US is a non-invasive method imaging of internal structures including abdomen,
- thorax (heart), eye, and appendages.
- Musculoskeletal
- Obestetrics
- Ultrasound guided analgesia

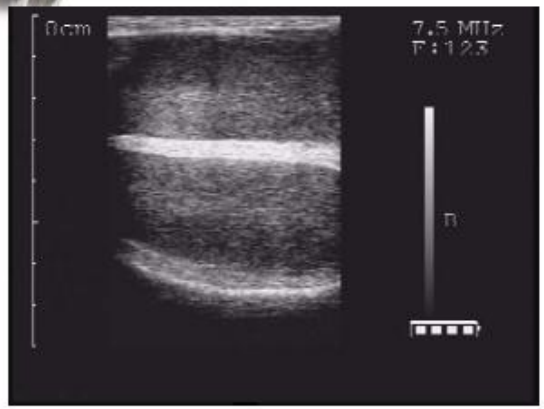
# Pregnancy diagnosis


- use of ultrasound allows also to move faster pregnant cows out of confinement and therefore decrease feed costs;a 1.000 cows farm pays for a new ultrasound system with the savings on feed cost after 2 months.
- • failed estrus detection alone accounts for losses of 300 millions US dollars/year in the US dairy industry !!!

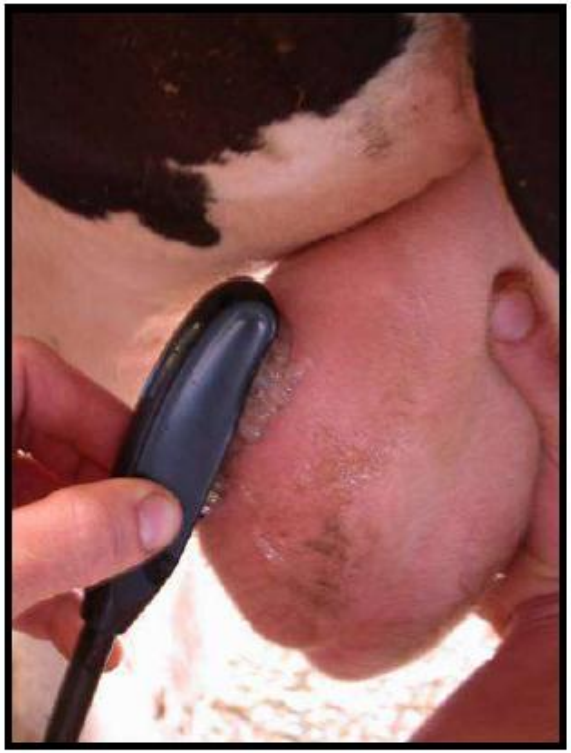
# Testis evaluation

Bull Tracts Exam

ECM
Noveko International Inc.



(Testicle Ipoplasia)



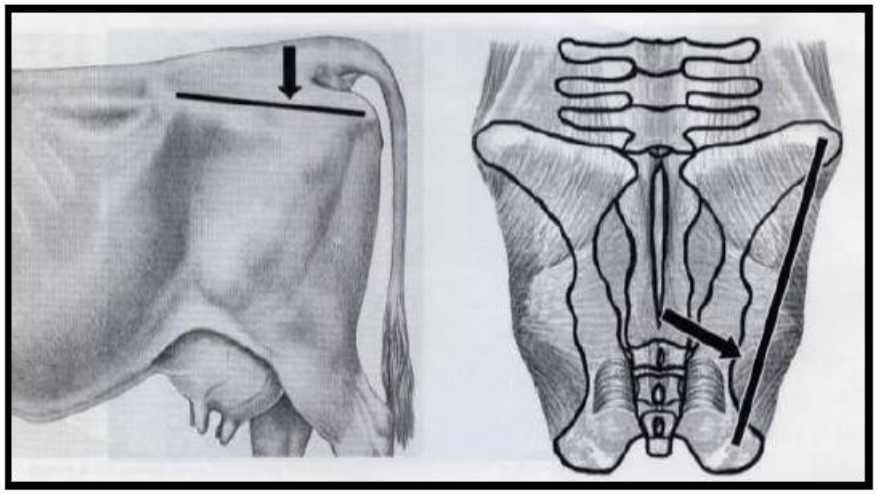
# Teat evaluation


Teat Lesions control

# Body condition scoring

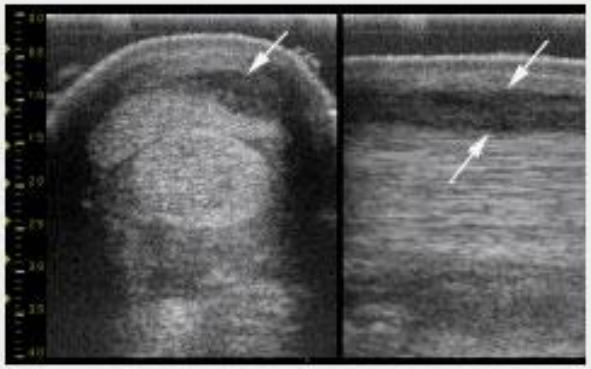
ECM
Novelco International Inc.

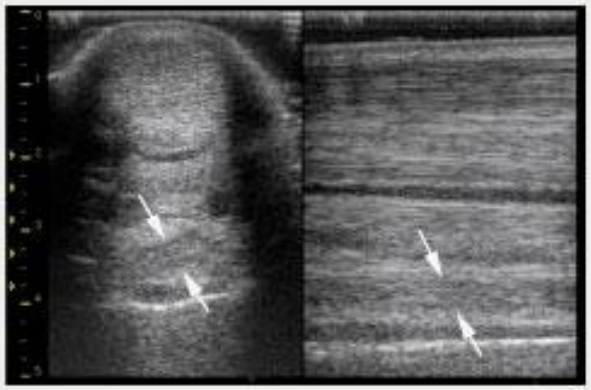
**BACK FAT MEASUREMENT**



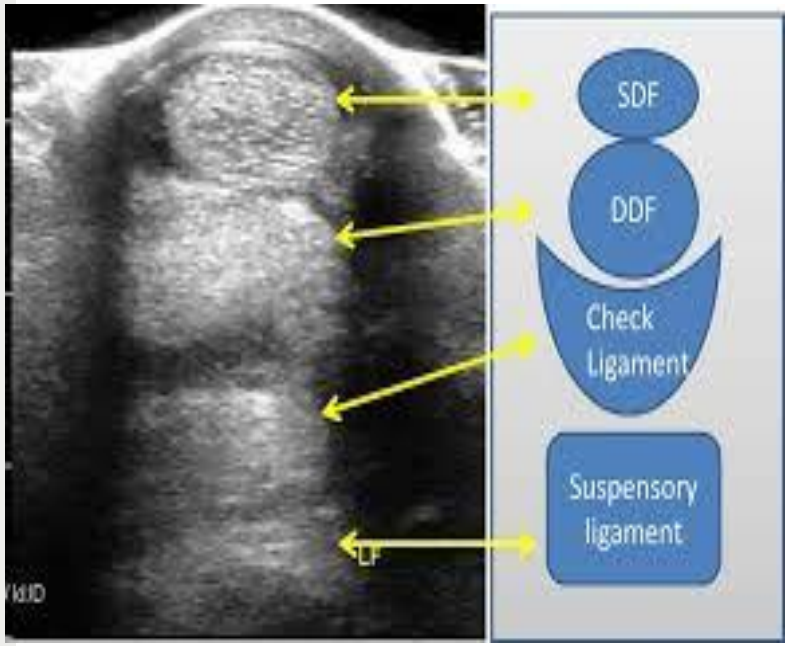
# Joint evaluation

# Tendon affections





Ultrasound evaluation of the equine metacarpal region reveals a recent acute tear of the superficial digital flexor tendon in the upper right image. The lower right image reveals a tear of the proximal suspensory ligament in a Warmblood show horse.



## Modes of Ultrasonography

# A-mode – one-dimensional

- Distances between reflecting interfaces and the probe are shown.
- Reflections from individual interfaces (boundaries of media with different acoustic impedances) are represented by *vertical deflections* of base line, i.e. the echoes.

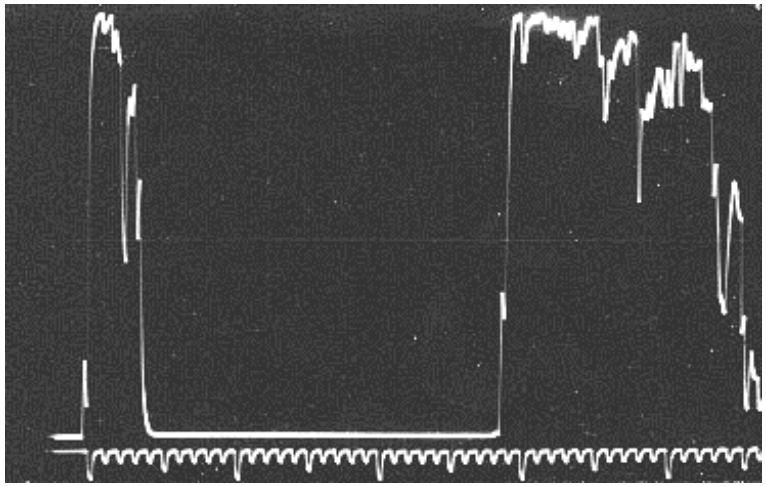
Echo amplitude is proportional to the *intensity of reflected waves* (Amplitude modulation)

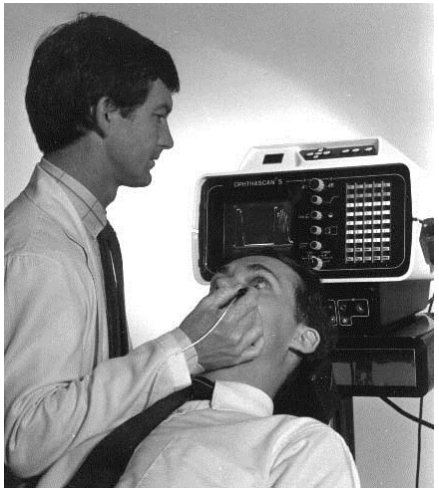
Distance between echoes shown on the screen is approx. proportional to real distance between tissue interfaces.

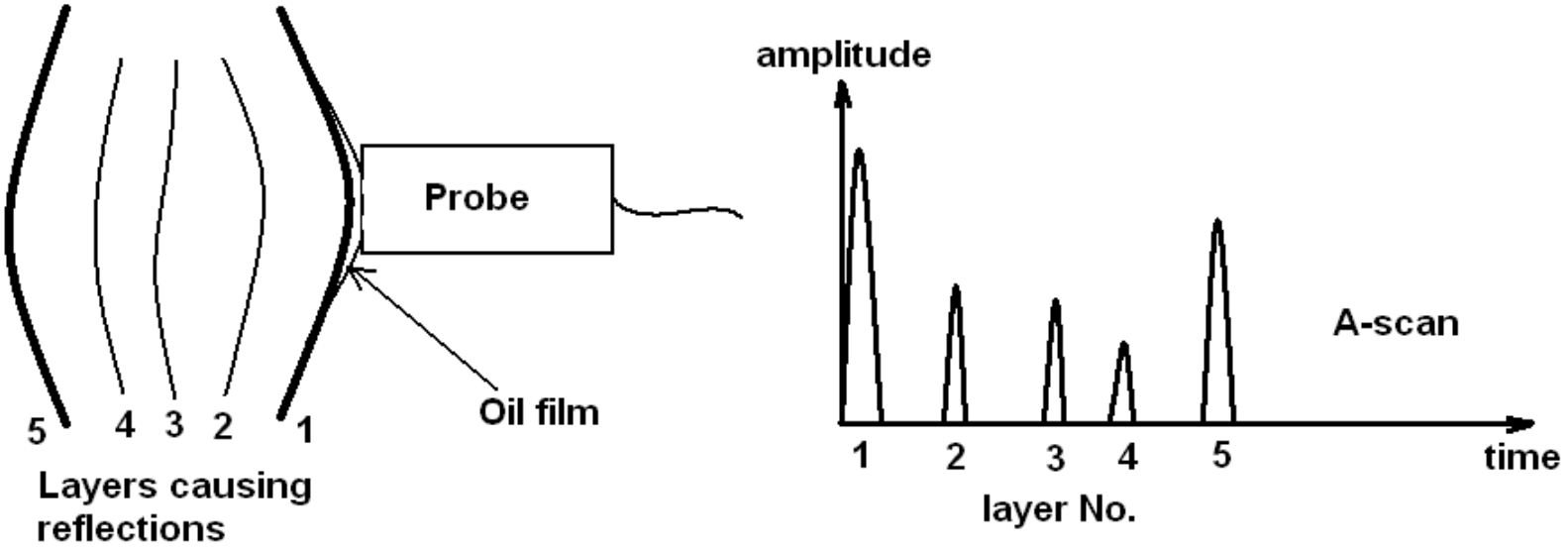
Today used mainly in ophthalmology.

Ultrasonography

# A-mode – one-dimensional








PRINCIPLE OF A-MODE SCAN

Ultrasonography

# B-mode – two-dimensional

A tomogram is depicted.
Brightness of points on the screen represents intensity of reflected US waves (Brightness modulation).

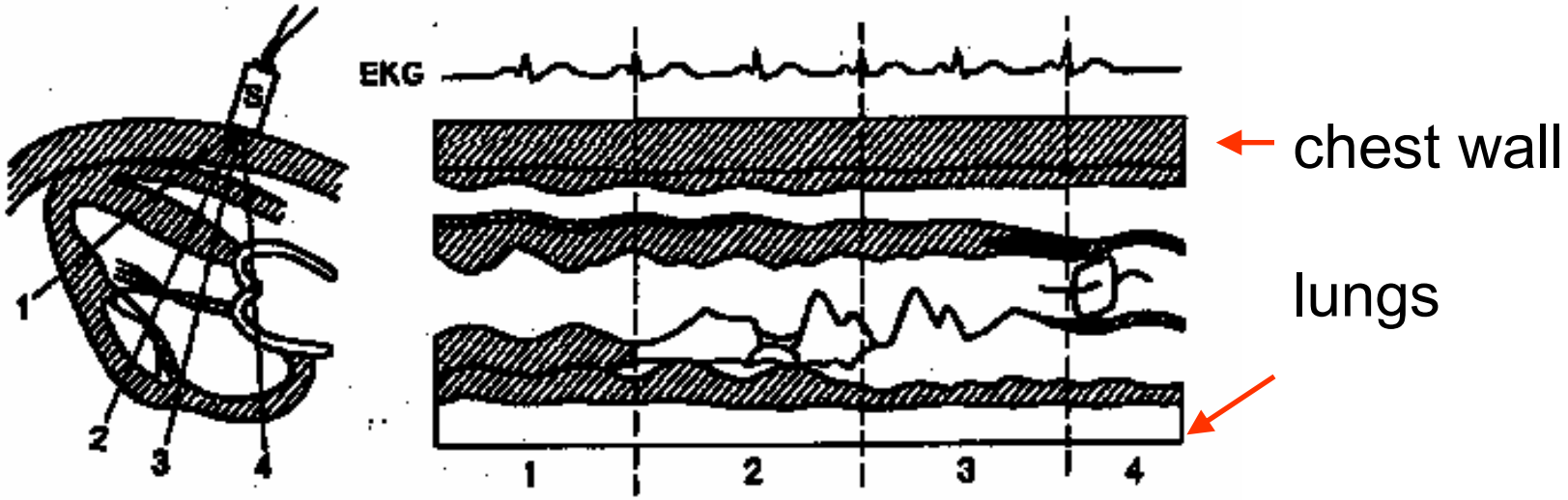
Static B-scan: a cross-section image of examined area in the plane given by the beam axis and direction of *manual* movement of the probe on body surface. The method was used in 50‘ and 60‘ of 20th century

# Ultrasonography M-mode

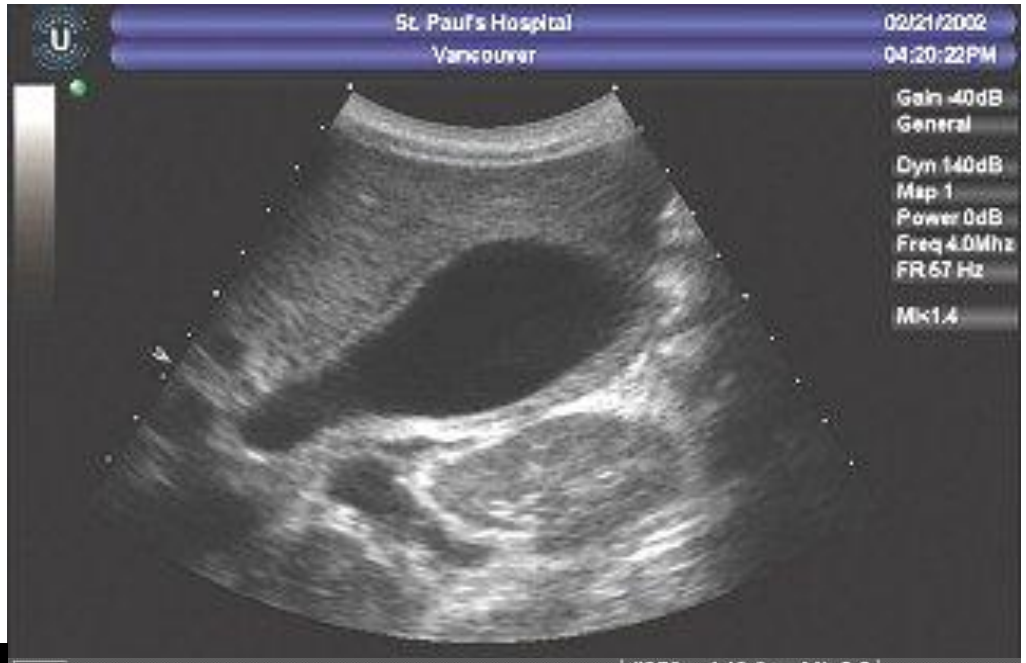
One-dimensional static B-scan shows movement of reflecting tissues. The second dimension is time in this method.

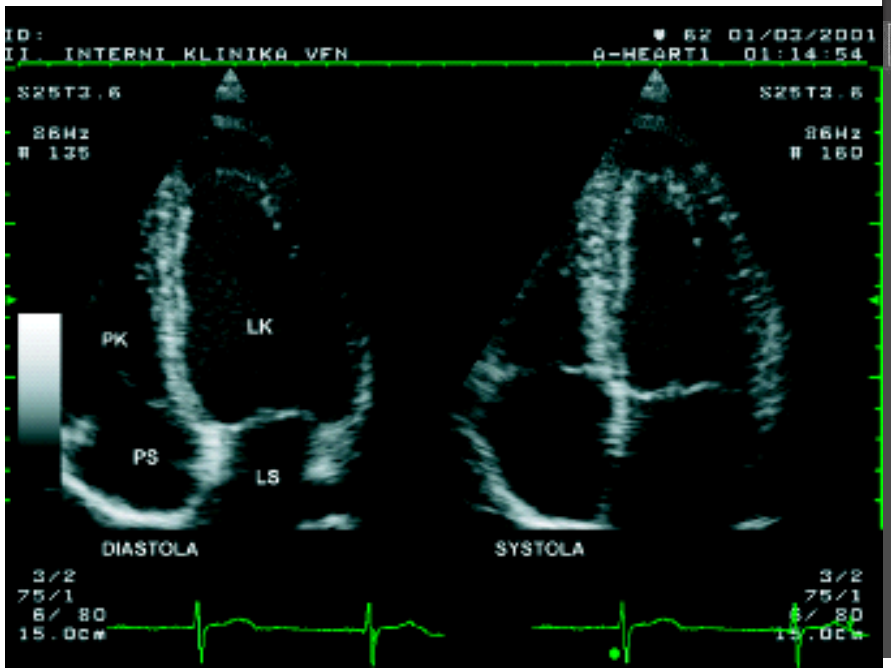
Static probe detects *reflections* from moving structures. The bright *points* move *vertically* on the screen, *horizontal shifting* of the record is given by slow time-base.

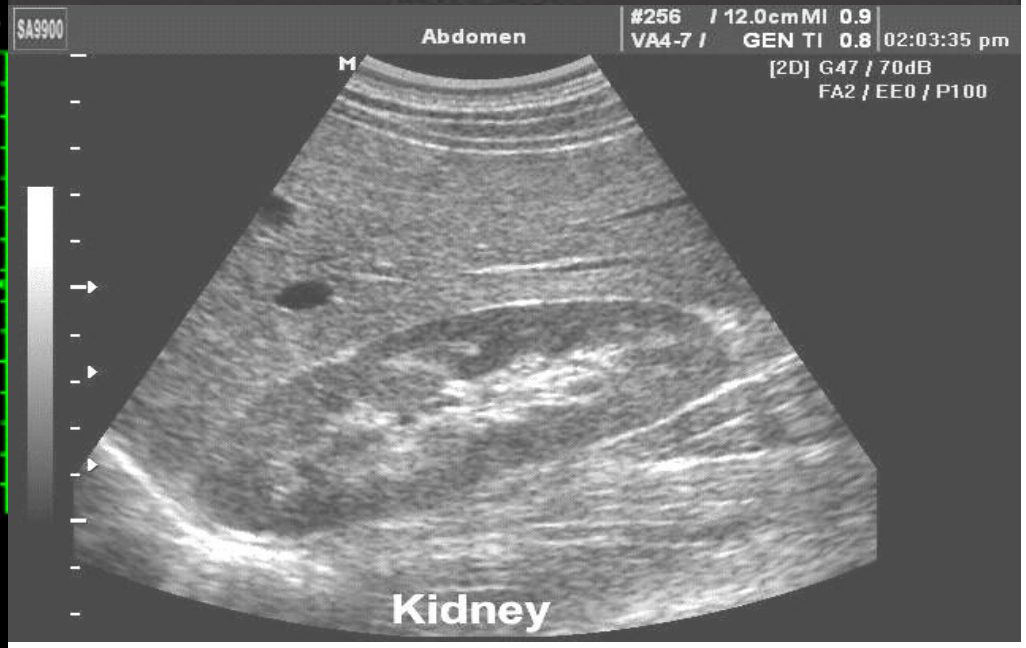
Displayed curves represent *movement* of tissue structures

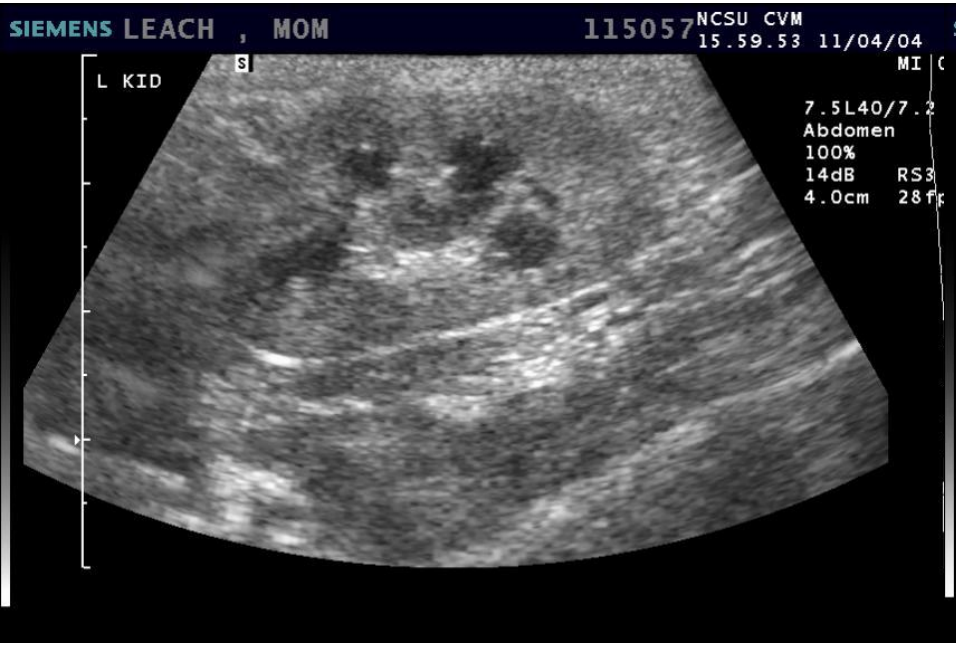


# Ultrasonography B-mode - dynamic



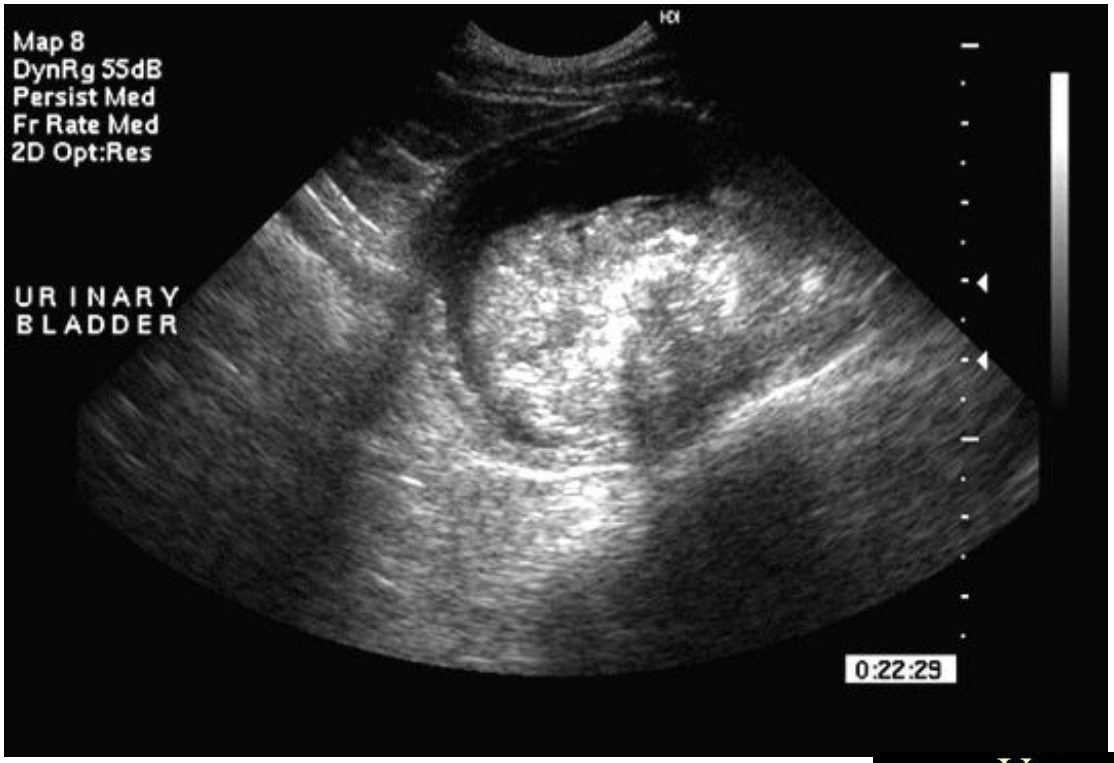



Without Harmonics


With Harmonics

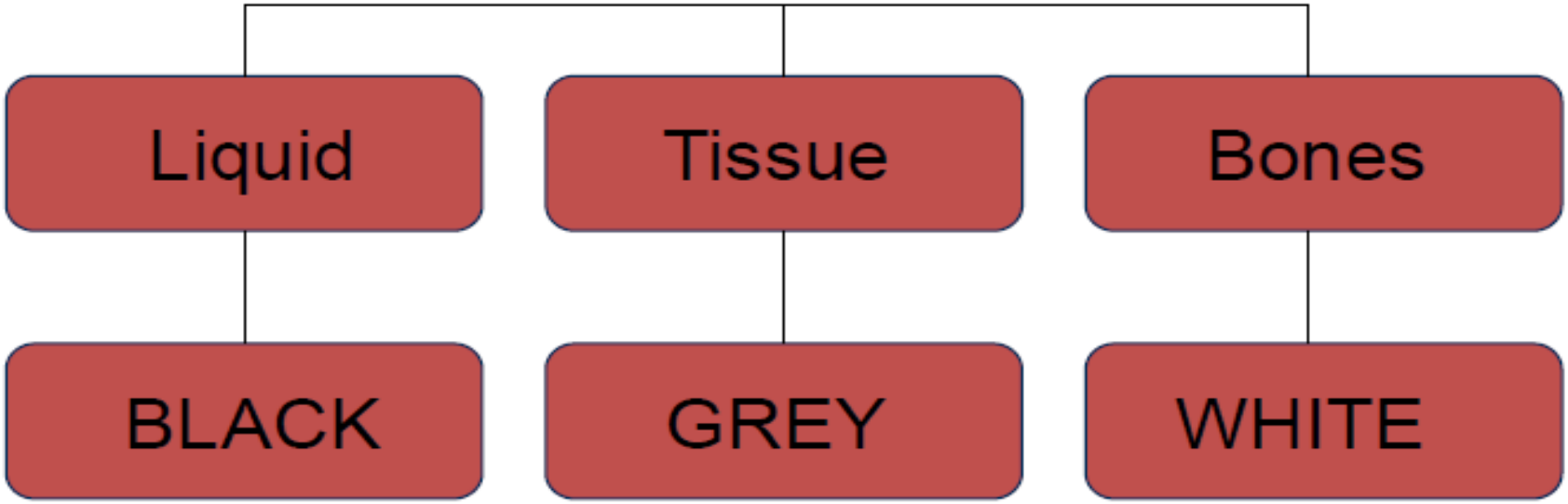
# B-mode interpretation

- Hyperechoic
- Hypoechoic
- Isoechoic
- Anechoic




ECM
Noveko International Inc.

# Ultrasound principle




256 tones of grey

# Preparation for examination

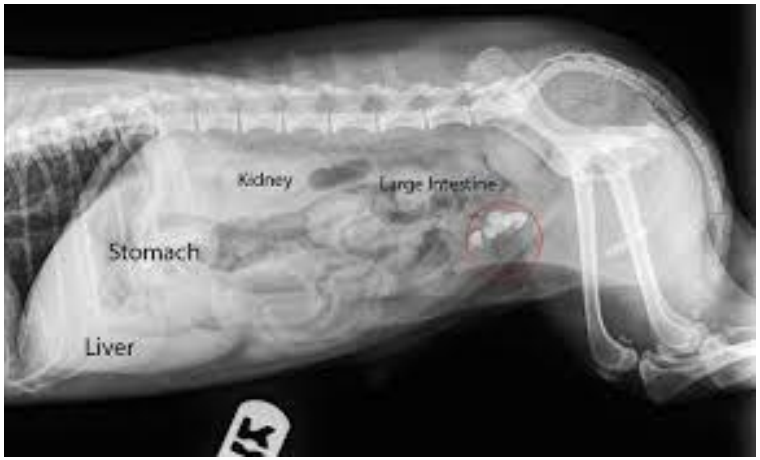
- Clipping & shaving
- Coupling  of gel

# *Positioning for exams*

- Some veterinary sonographers prefer their patients in a V-trough in dorsal recumbency. But This makes the kidneys (particularly the right kidney), adrenal glands, and some other organs difficult to find or examine thoroughly.


# *Systematic US examination left*

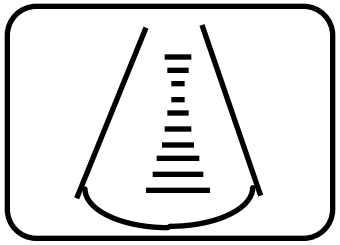
- As you perform the exam, your **mental "checklist" will help guide the** examination. My routine abdominal exam begins with the structures on the left side (patient in right lateral recumbency) and proceeds as follows:

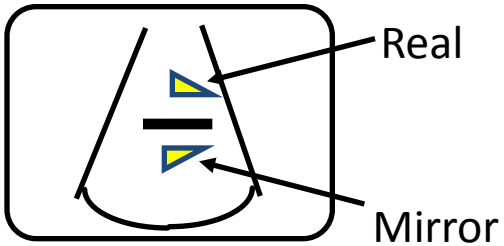



- Spleen (head, body, tail)
- • stomach
- • liver, left side to middle
- • left kidney
- • urinary bladder and prostate
- • Descending colon and small bowel

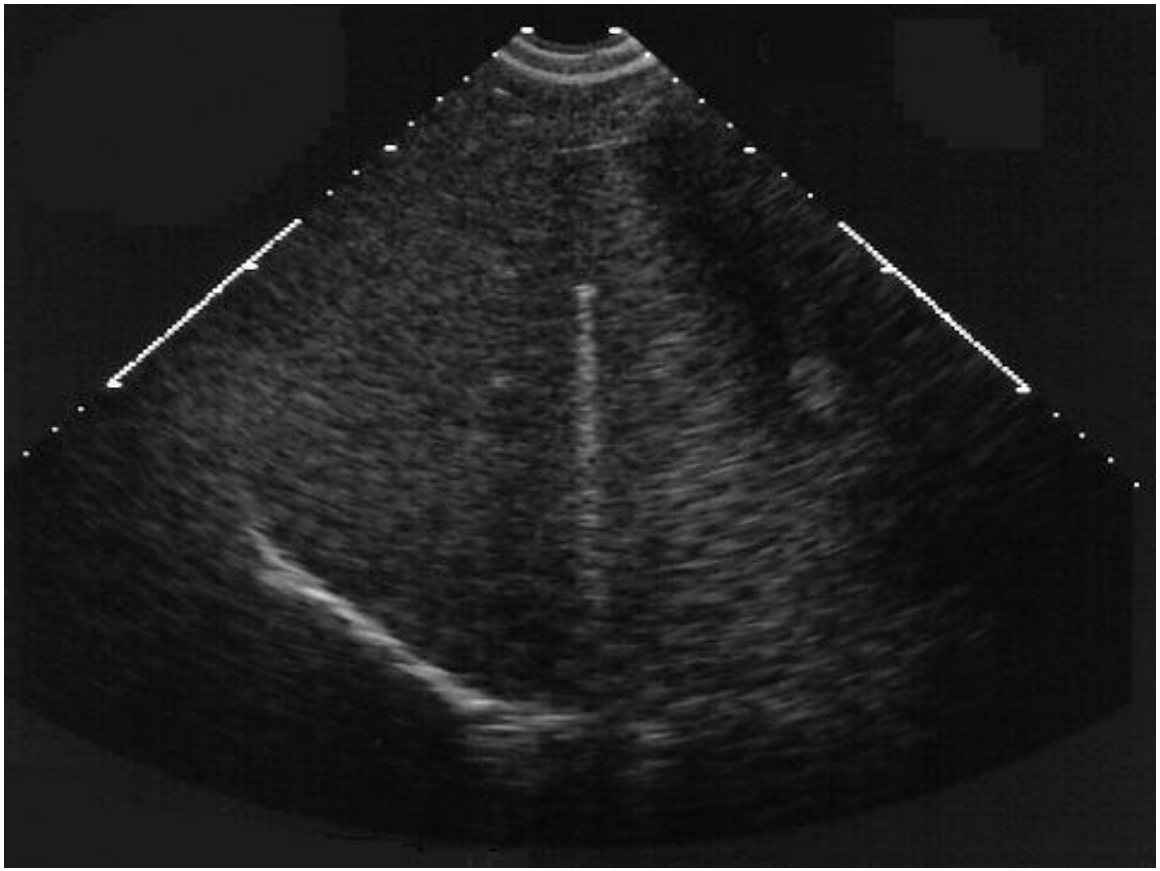
# Artifacts

- Artifacts are un wanted echoes that does not represent actual structure
- **Reverberation (multiple echo) artifact**
  - "comet tail" effect is 1 example
  - can have dozens of multiple reflections between
    - transducer & reflector
    - 2 reflectors
- Mirror Image
  - common around diaphragm & pleura





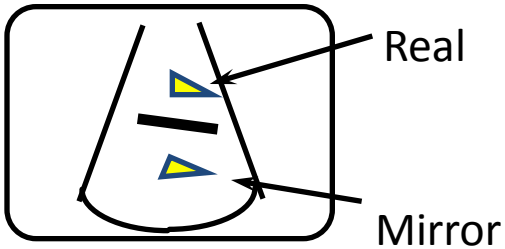
# Artifacts

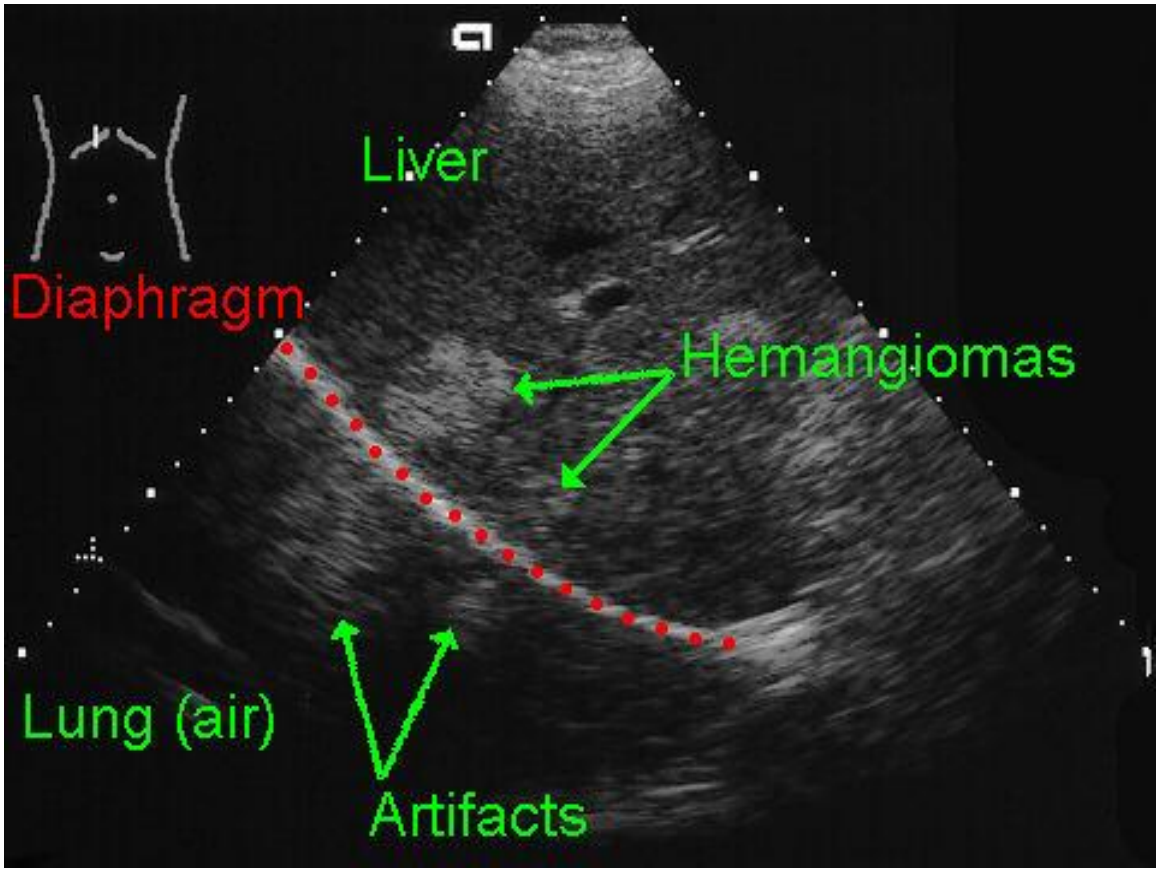


http://raddi.uah.ualberta.ca/~hennig/teach/cases/artifact/noframe/imag1-f1.htm

Caused by Shotgun Pellets

# Multiple Reflection Scenario

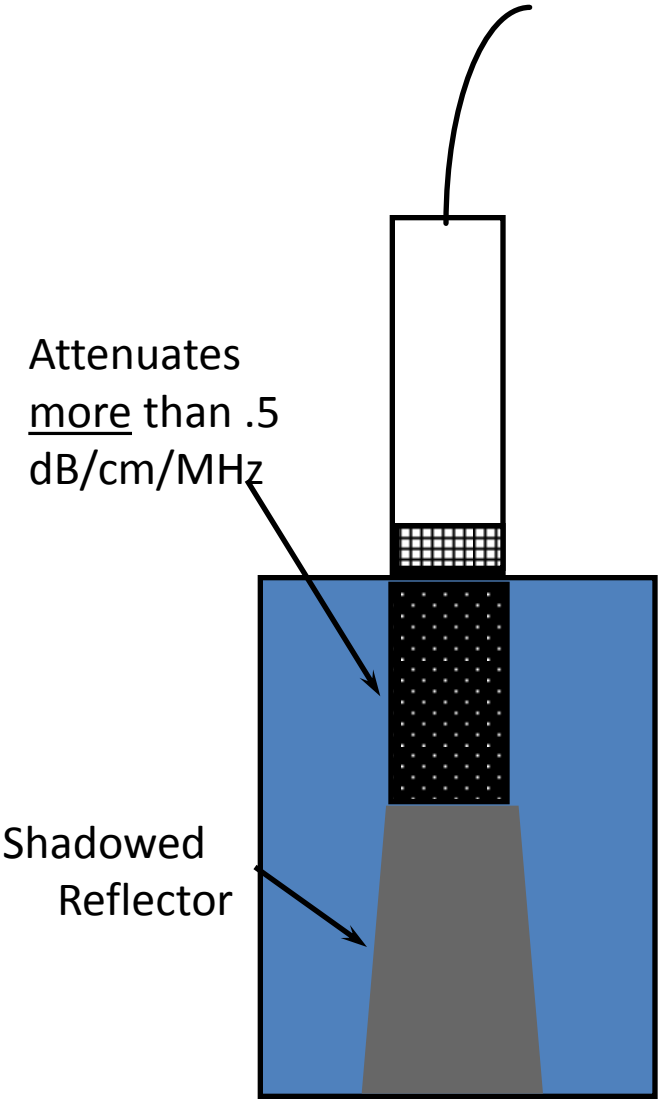



http://raddi.uah.ualberta.ca/~hennig/teach/cases/artifact/noframe/imag5-f2.htm

# Shadowing

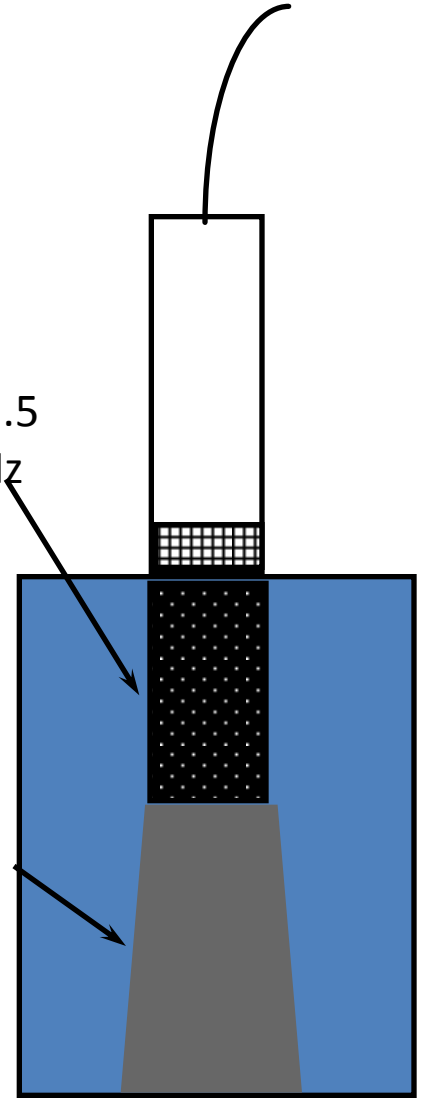
- Clinical Manifestation
  - reduction in imaged reflector amplitude
- Cause
  - object between this reflector & transducer attenuates ultrasound more than assumed
  - assumed compensation not enough to provide proper signal amplitude
  - intensity under-compensated
- Opposite of Enhancement



# Shadowing


Attenuates
more than .5
dB/cm/MHz

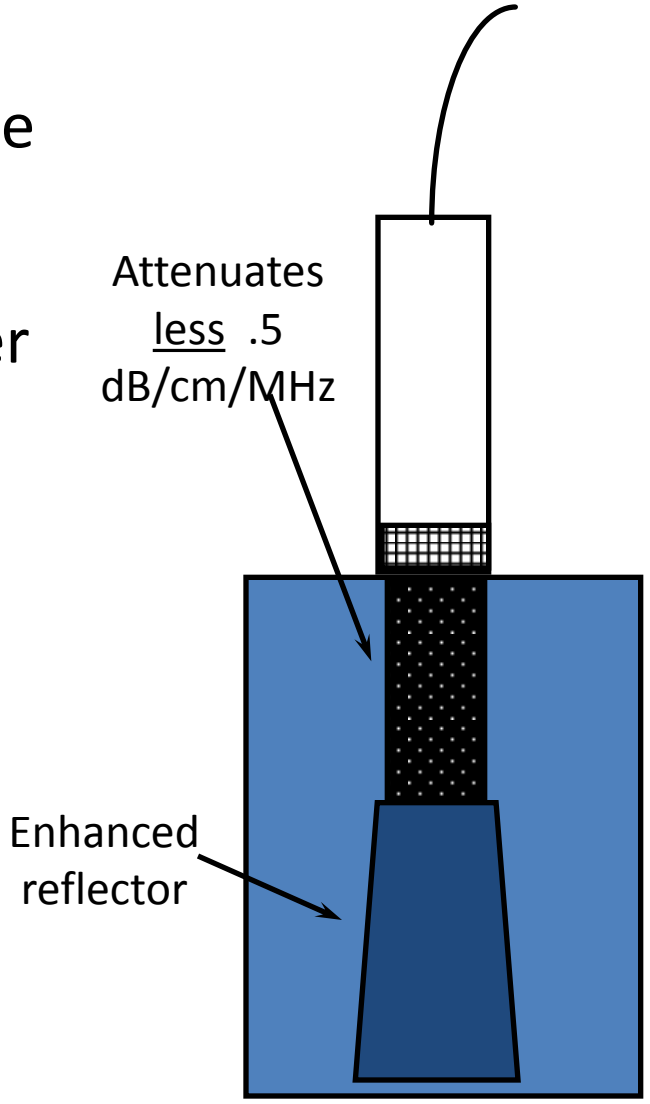
Shadowed
Reflector



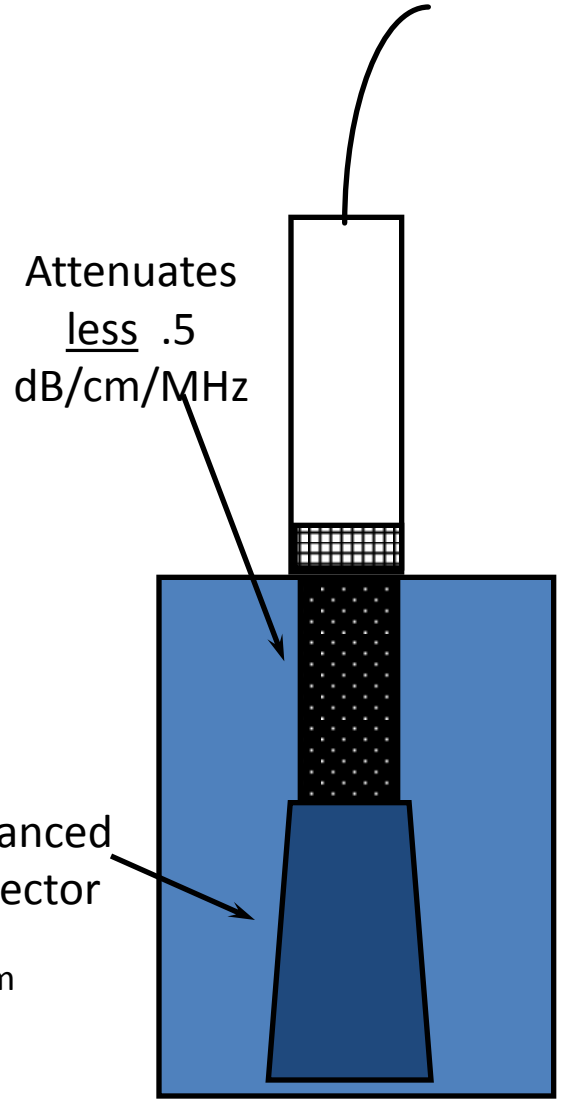
http://raddi.uah.ualberta.ca/~hennig/teach/cases/artifact/noframe/imag2-f2.htm

# Enhancement

- Clinical Manifestation
  - increase in imaged reflector amplitude
- Cause
  - object between reflector & transducer attenuates ultrasound less than assumed
  - assumed compensation more than needed to provide proper signal amplitude
  - intensity over-compensated
- Opposite of Shadowing



# Enhancement

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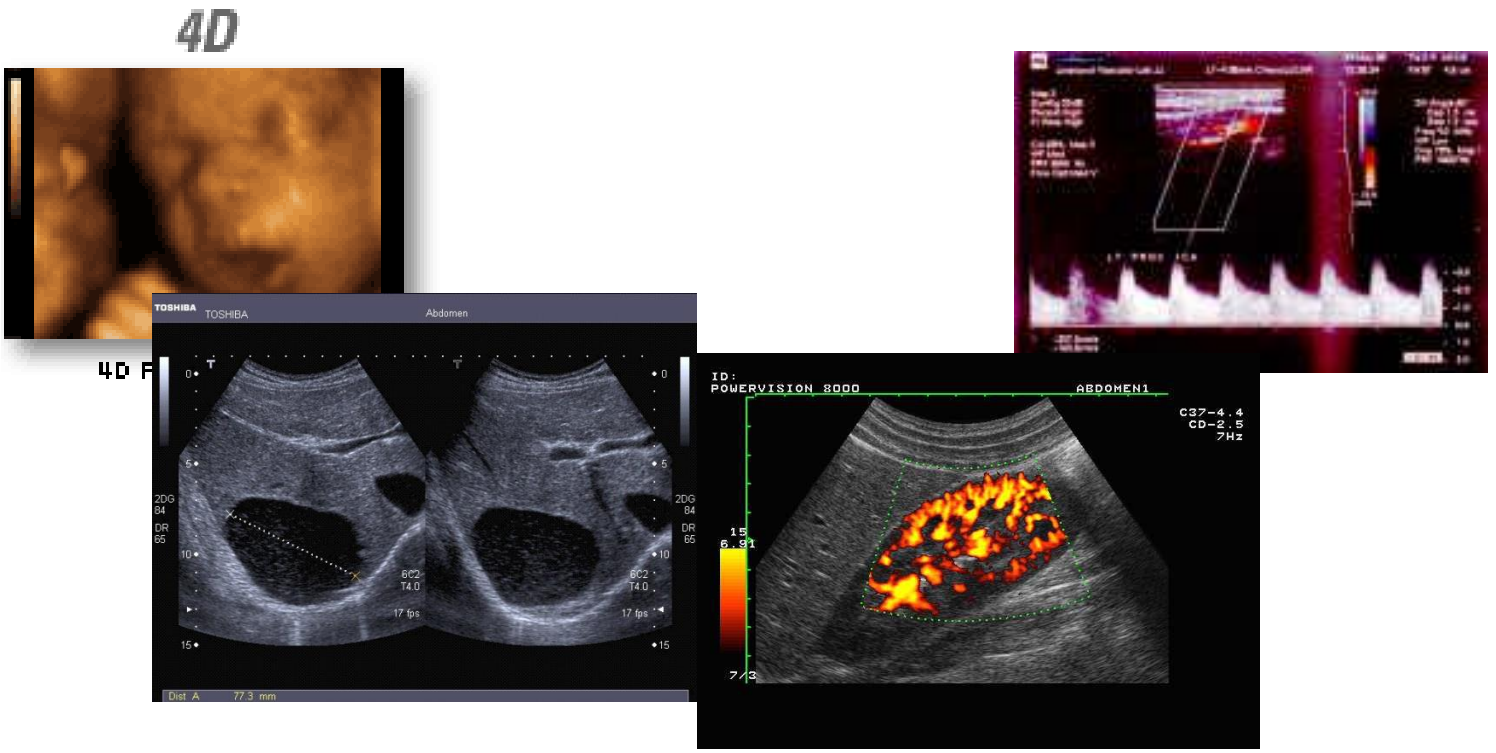
# Diagnostic Ultrasound Forum

Abdelhaeem H, El-Kasapy

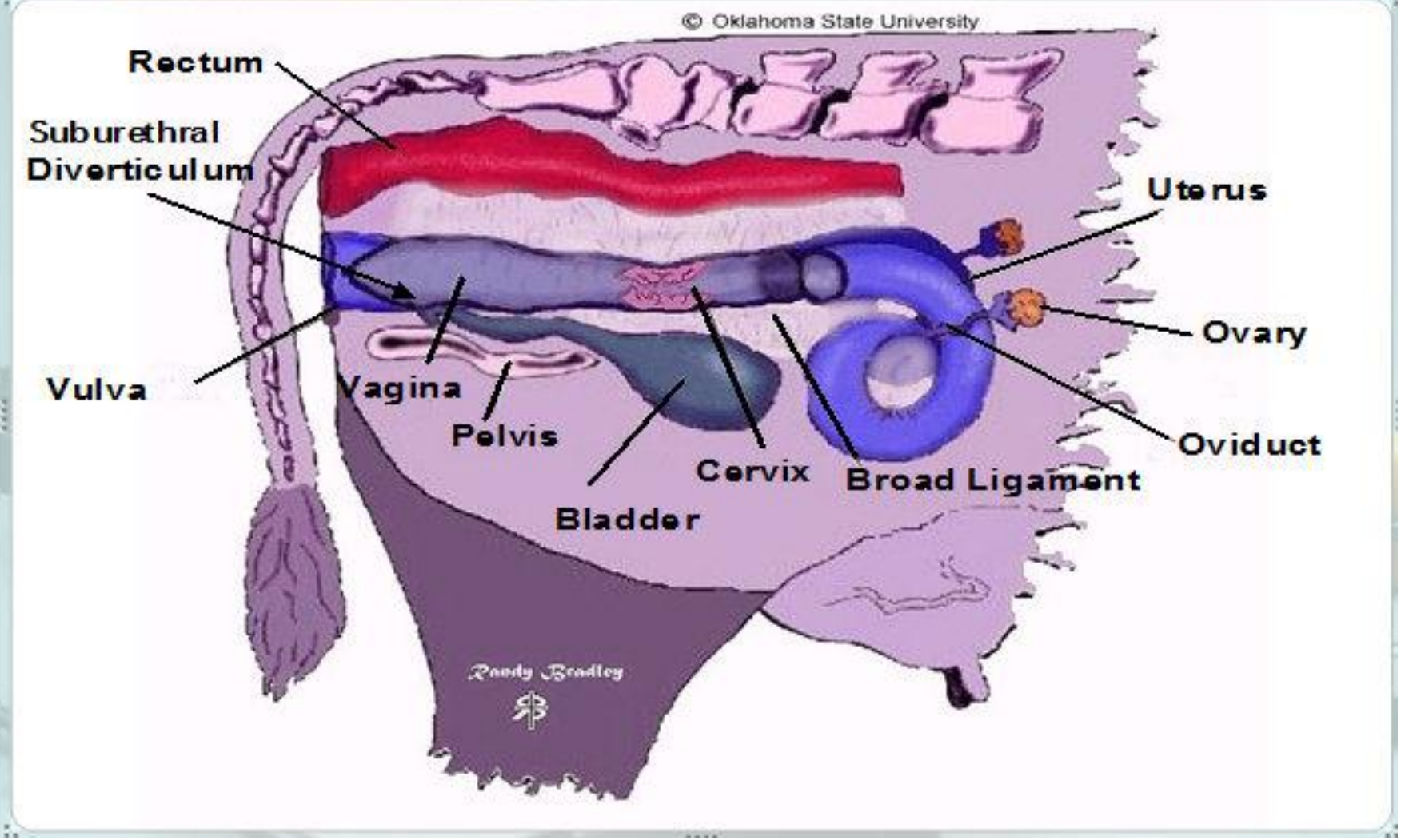



## Ultrasound diagnostics

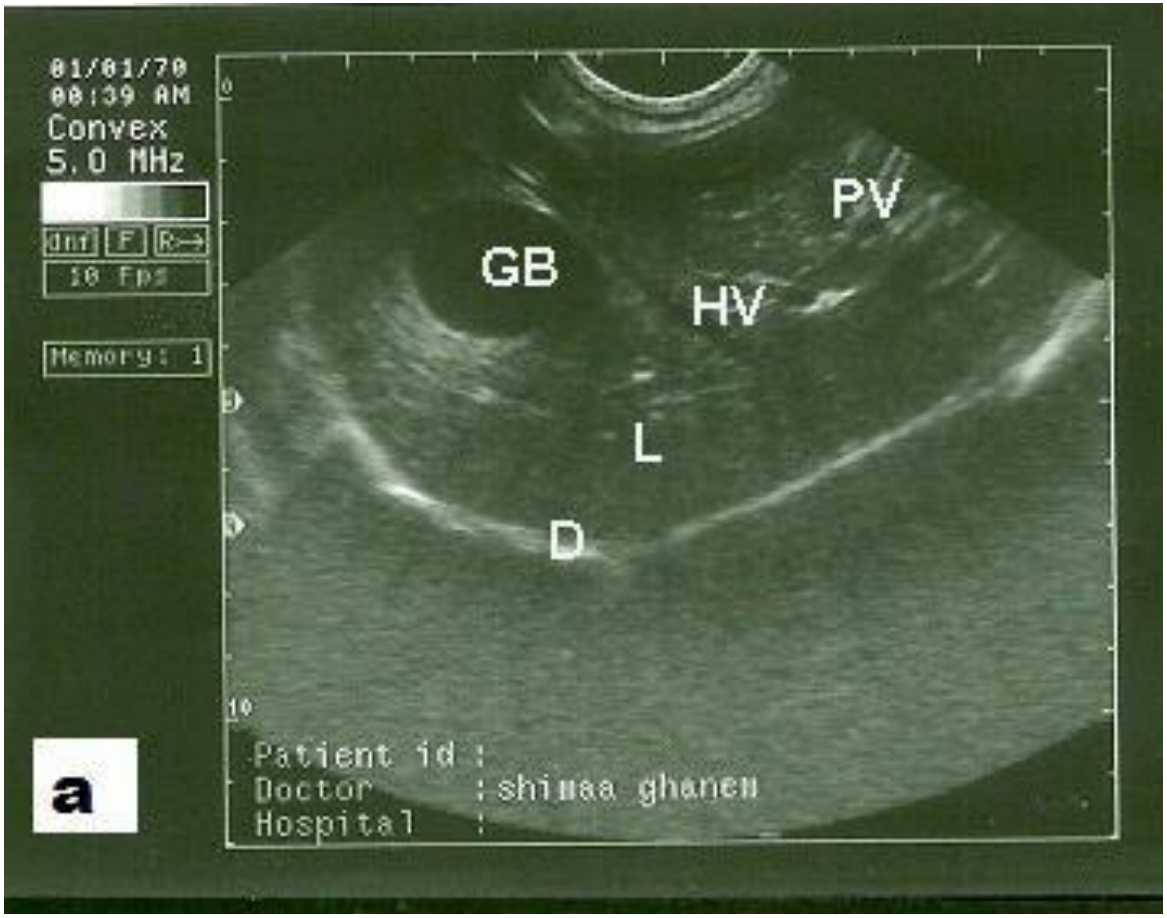
# How to learn Ultrasound

- **Before practical you must know:-**
- Normal anatomy
- View pathology
- Orientation of probe

# Bovine Anatomy

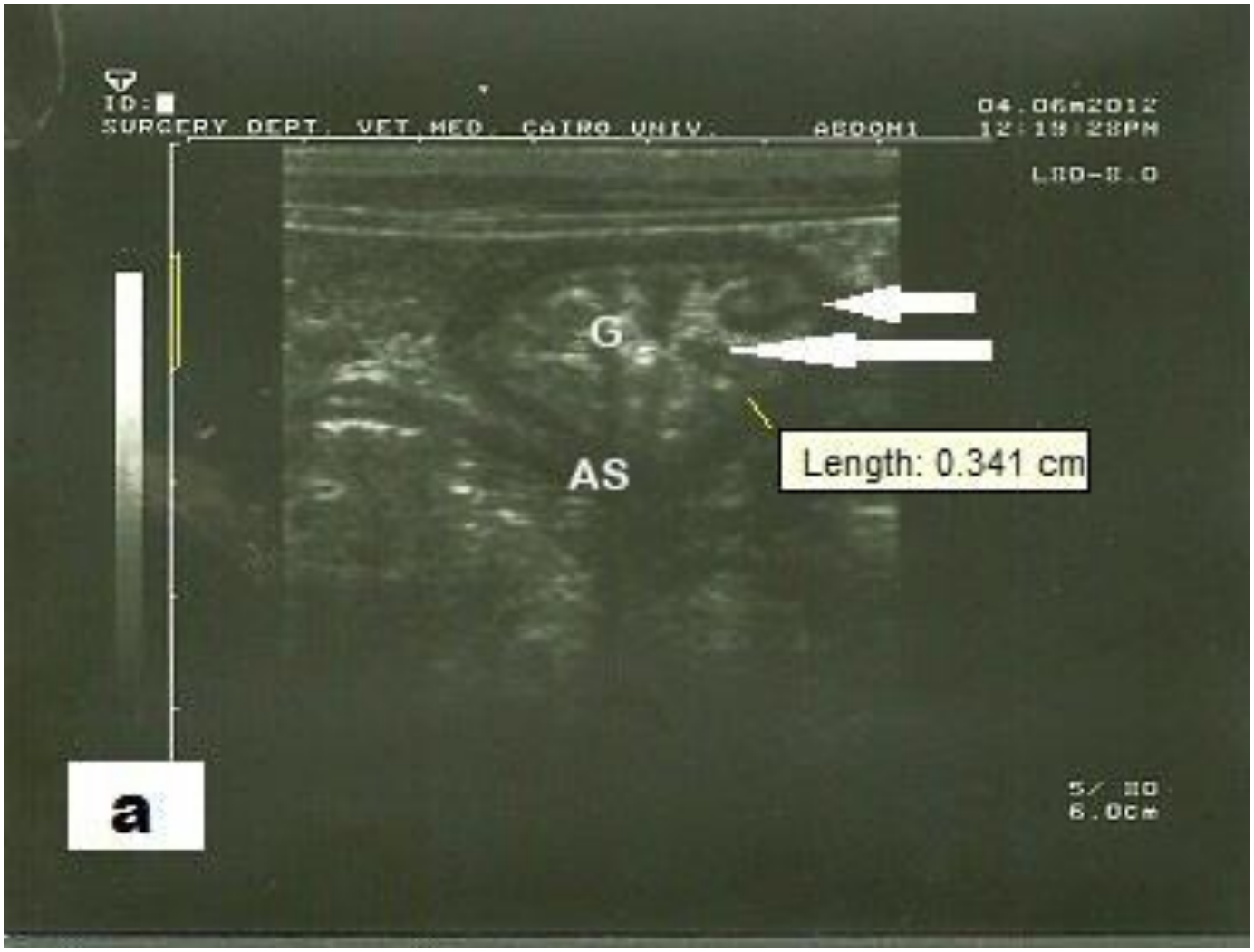


# liver




- showing homogenous pattern and moderately echoic appearance interrupted by
- anechoic gall bladder (GB) , short highly echogenic paired parallel lines
- surrounding an anechoic lumen that represent the portal veins (PV) , anechoic
- linear structures that represent the hepatic veins (HV) and margined by
- hyperechoic diaphragm (D).

# Stomach

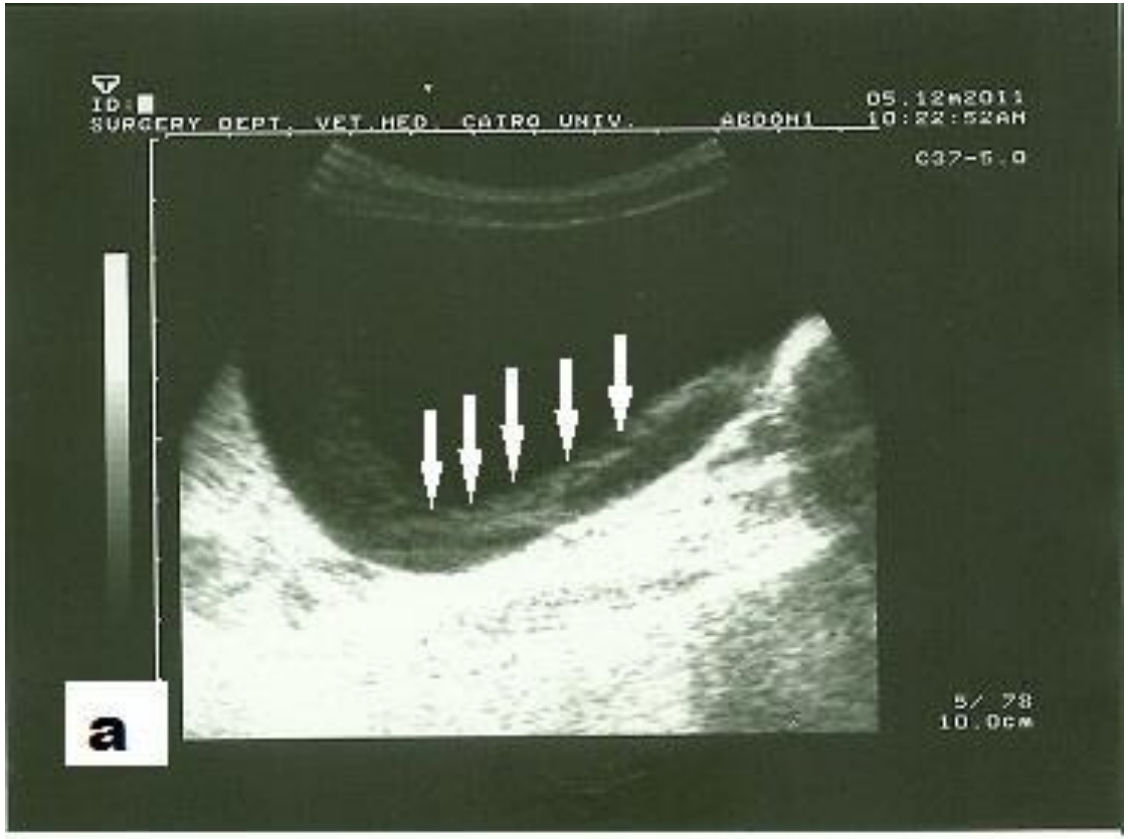



- **(a) Transverse image of stomach in 1.5 -year-old mongrel dog. Note the hypoechoic**
- wall (short arrow), the star shape rugal folds and central fluid or gas echogenicity
- (long arrows). The wall thickness is 3.4 mm

# spleen

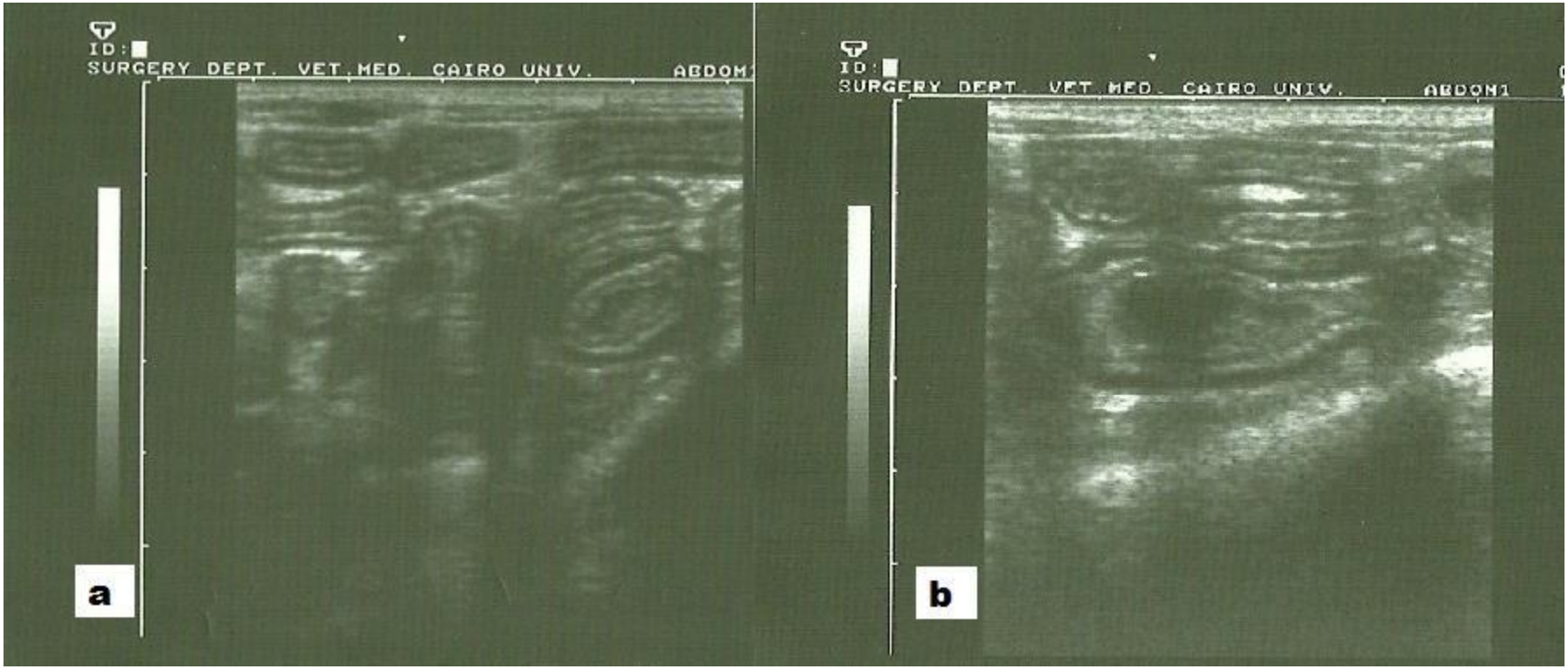

- **(a) Sagittal sonogram of normal spleen in 8 -months-old German shepherd dog**
- showing a dense, homogeneous, granular, speckled echotexture. Anechoic splenic
- vessels are sparsely scattered throughout the splenic tissue (arrow).

# Urinary bladder




- Sagittal sonogram of normal urinary bladder showing Slice-thickness artifacts, which mimic the presence of sediment „Pseudo-
- Sediment" (arrows).

# intuss




- obstruction showing concentric hypoechoic and hyperechoic rings of intussusceptum and intussuscipiens "ring" or "bull's eye" sign.


Vet Abd Sm. + Length 3.40 cm
C8-5
40Hz
6cm
RT AD
2D
Res
Gn 62
47
3/3/3
VOZELLA
Acq Dt: 08/09/2012
Acq Tm: 14:26:21.90000
G
P
R
5.0 8.0
US

# UB tumor

# Calculi


PHILIPS , SOPHIE
8914 Exclusively Cats Veterinary Hospital
MI 0.9
TIS 0.1
3/13/2015
12:58:15 PM
Ped Abd
C8-5
44 Hz
6.0cm
Length 1.27 cm
Depth 2.08 cm
2D
Gen
Gn 50
C 56
3/4/2

# UB Blood clots

# The Ultrasound Machine

- A basic ultrasound machine has the following parts:
  - **transducer probe** - probe that sends and receives the sound waves
  - **central processing unit (CPU)** - computer that does all of the calculations and contains the electrical power supplies for itself and the transducer probe
  - **transducer pulse controls** - changes the amplitude, frequency and duration of the pulses emitted from the transducer probe
  - **display** - displays the image from the ultrasound data processed by the CPU
  - **keyboard/cursor** - inputs data and takes measurements from the display
  - **disk storage device** (hard, floppy, CD) - stores the acquired images
  - **printer** - prints the image from the displayed data

# Transducer Probe

- The transducer probe is the main part of the ultrasound machine.
  - The transducer probe makes the sound waves and receives the echoes.

# Types of probes

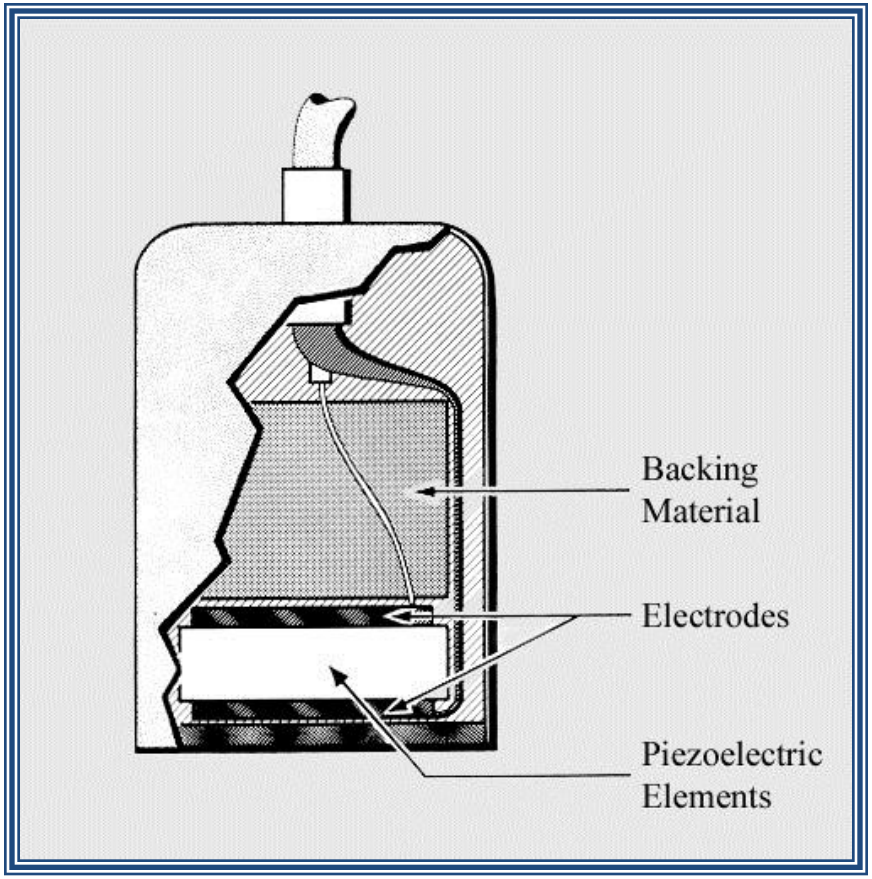
# Type of Probes

Curvilinear Probe: General OB and Abdominal applications

Linear, High Frequency Probe: vascular, small parts and MSK applications

Endo-Cavity Probe: Vaginal, Rectal applications. Very useful in early pregnancy

Cardiac Probe : Used for Echocardiography applications


Backing
Material
Electrodes
Piezoelectric
Elements

# Central Processing Unit (CPU)

- The CPU is the brain of the ultrasound machine.
  - The CPU is basically a computer that contains the microprocessor, memory, amplifiers and power supplies for the microprocessor and transducer probe.

- **The CPU** sends electrical currents to the transducer probe to emit sound waves, and also receives the electrical pulses from the probes that were created from the returning echoes.
  - The CPU does all of the calculations involved in processing the data.

# Display

- The display is a computer monitor that shows the processed data from the CPU.
  - Displays can be black-and-white or color, depending upon the model of the ultrasound machine.

# Keyboard/Cursor

- Ultrasound machines have a keyboard and a cursor, such as a trackball, built in.
  - These devices allow the operator to add notes to and take measurements from the data.

# Ultrasound scanning controls

- **Image orientation**
- • Sagittal and dorsal scan planes -- cranial aspect of the patient or organ is on the left of the video display
- • Transverse scan planes -- right aspect of the patient or organ is on the left of the video display


1: Power button
2: Baseline key
3: Scale key
4: Page key
5: Unassigned
6: Steer key
7: Split key
8: Focus key
9: Depth key
10: Body Marker key
11: Text key
12: PW mode key
13: Color mode key
14: 2D mode key
15: CW mode key
16: Gain/Active control
17: Clear key
18: Calcs key
19: Caliper key
20: Select key
21: Cursor key
22: M-Mode key
23: Zoom control
24: Update key
25: Left Enter key
26: Trackball
27: Right Enter key
28: Freeze key
29: Store key
30: Record key

**Terason Console**

# Depth of field adjustment

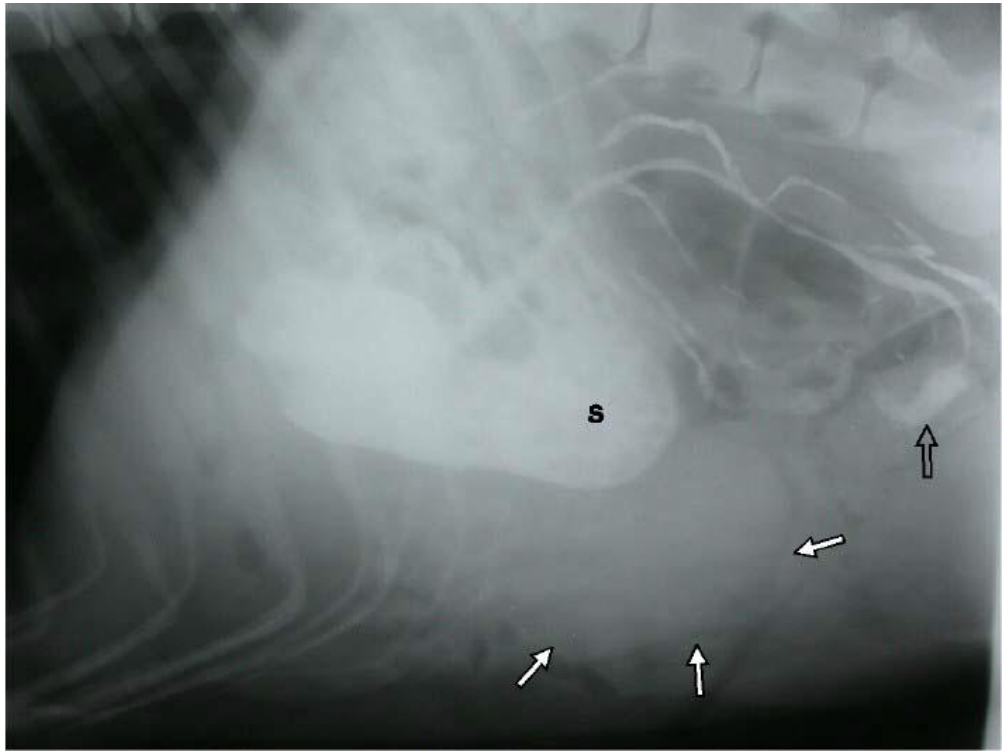
- Depth of field can be adjusted to visualize a specific area of interest within an
- organ or to visualize the entire organ. A depth of field that is too shallow will cut off part
- of the field, while a depth of field that is too deep will show a great deal of black space
- deep to the organ or area of interest.

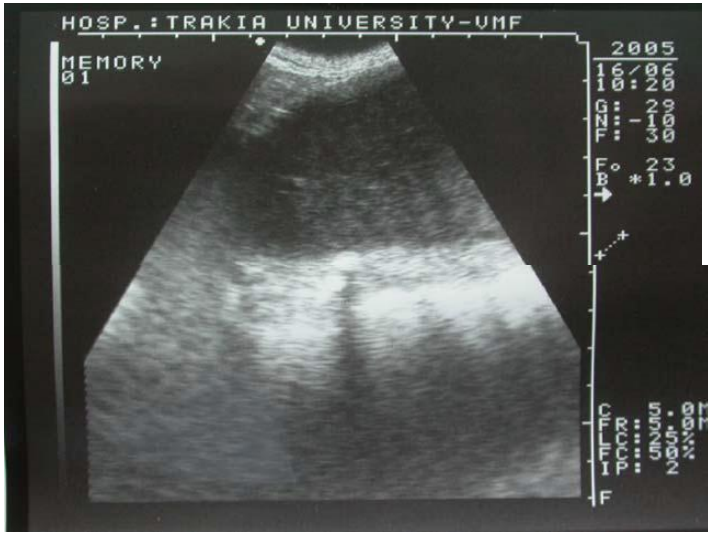
# Focal points

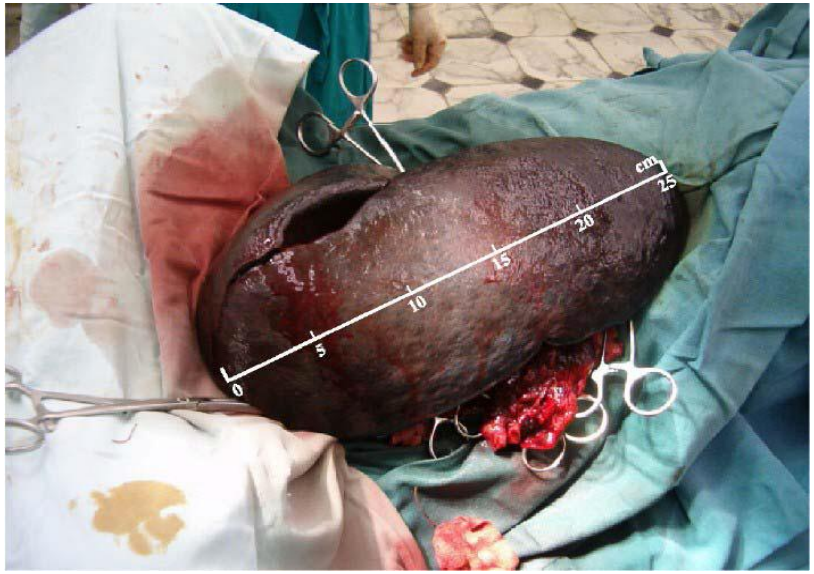
- The focal points are indicated on the edge of the image by one or more small arrowheads. The focal point should be set at the level of the specific area of interest that
- you are viewing to optimize the resolution of the image at that depth. The disadvantage of
- multiple focal points is that the frame rate become slower in the image may appear to
- "swim" or look "jerky".

# Gain settings

- Gain is the amount of amplification applied to returning ultrasound echoes.
- Gain is often divided into near-field and far-field gain settings, and an overall gain setting.
- As a rule of thumb, first reduce the near-field gain and preserve or boost the far-field gain to obtain a balanced image, and then use the overall gain setting to increase or decrease the brightness of the image.
- Together, power and gain settings are used to obtain a visually pleasing gray-scale image that is uniform in both the near and far fields.




- Torsion of spleen

# THANK YOU

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