ULTRASONOGRAPHY IN VETERINARY PRACTICE

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Among the numerous advances in veterinary diagnostic procedures, ultrasonic imaging technique is the most rewarding. It has developed at a rapid rate in the past few decades and became an important aid in the speciality areas in clinical veterinary medicine, such as internal medicine, gynecology and obstetrics, surgery, cardiology, gastroenterology, orthopedics and ophthalmology. This technique has become so popular since it is a simple non invasive procedure that rarely needs the use of tranquilizers.The technique is apparently safe to patients and affordable to clients.

Advantages and disadvantages of ultrasonography:

As an imaging modality, ultrasound has many benefits.

- Nonionising form of energy that has no known health risk.
- Able to locate radiolucent objects, like urates and cystine uroliths and foreign bodies such as wood, string etc.
- Organs like pancreas, adrenal glands, ovaries, lymph nodes and internal structures of eye are not recognized radiographically can be viewed.
- Discriminating cystic vs. solid masses.
- Interrogating of body cavities filled fluids that prohibit radiographic techniques.
- Discriminating the texture of suspected solid masses.
- Cardiac evaluation.
- Muscle and tendon evaluation.
- Pregnancy diagnosis.
- Biopsy guidance for internal masses and cystocentesis.

The disadvantages reside in difficulties encountered when applying ultrasonography to tissues such as bones and air filled structures (lung and intestine). As with many other imaging methods, ultrasonography requires a precise knowledge of anatomy, a three dimensional understanding and a great deal of practice. These facilitates to reach proper diagnosis of pathological conditions of various tissues.

What is ultrasonography?

Ultrasonography is a medical imaging technique that uses higher frequency sound waves and their echoes. The technique is similar to the echolocation used by dolphins, as well as sonar used by submarines. Ultrasound is a high frequency sound wave. Our audible range of sound is 20-20,000 Hertz (Hz) (cycles per second) For diagnostic applications, frequency of 2-10 MHz are used. Like audible sound, ultrasound cannot be propagated in vacuum and in gas, transmission is poor. Reflections of ultrasound occur between substances of different acoustic impedance.
Principle of Ultrasonography

Diagnostic ultrasound is produced by transducers housing crystals with piezo-electric properties. When a voltage is applied across such crystal, it undergoes mechanical deformation and thus produces sound of a characteristic high frequency. The transducer is designed to produce short, regular pulses of sound. When the transducer is placed in contact with the body surface the sound passes through the tissues. Different tissues have a different resistance to the passage to sound or acoustic impedance. Whenever the sound reaches the inter phase between the tissues differing acoustic resistance the part of the sound is reflected back to the transducer which act as a transmitter as well as receiver. When the difference of acoustic resistance is great (eg: - air/ soft tissue or bone/soft tissue) then much of the sound is reflected and little continues to the

deeper tissues. When the difference in acoustic resistance is small (eg:- soft tissue/ soft tissue) then a smaller proportion is reflected and more passes into deeper tissues. The returning echoes are detected by the same transducer. When the returning echoes impinge on the crystal, they cause mechanical deformation. This will result in the production of small electrical signal. The electrical signals produced by the returning echoes are analysed according to their strength and time delay between emission of the sound signal and detection of the returning echoes. After analysis an image is displayed on the screen.

A basic ultrasound machine has the follows parts:

- Transducers /probe – Probe that emit and receive the sound waves.
- Central Processing unit (CPU)– Computer that does all the calculations
- Tranducer pulse contols - changes amplifier frequency and duration.
- Video Display – displays the image from the processed data.
- Keyboard – inputs data.
- Printer

IMAGE DISPLAY MODES

1) Amplitude mode (A mode): - This was the earliest display mode and is now rarely used.
2) Brightness mode (B mode): - This display mode is commonly used. Here the returning echoes are represented as a dot on the screen and the brightness of dot represents the strength of echo. This allows a two dimensional cross sectional image to be built up representing a slice through the tissues in the plane of the beam.
3) Motion mode (M mode): - A one dimensional imaging mode.This mode is often used in echocardiography.

TRANSDUCER CHARACTERISTICS

Based on the arrangements of crystals,there are two main types of ultrasound transducer.

a) **Linear array transducer: -** Crystals are arranged in a line along the surface of the transducer and are activated sequentially to produce a rectangular sound beam. Advantages of this type are it allows a wide field of view facilitating the recognition of the relationships between structures. Very superficial structures are well seen.

Disadvantages: -

Large contact area between the skin and transducer. So not ideal for examination of thoracic or cranial abdominal structures.

b) **Sector transducers:** - Mechanical sector transducer contain a single oscillating crystal or a small number of crystals mounted on a rotating wheel. Phased array transducer number of crystals are fixed in position and activated sequentially. In each case a fan shaped sound beam is produced. Since the contact area is small, it is idea for examination of thoracic organs.

Disadvantages:

Fan shaped beam of sector transducer does not allow good visualization of superficial structures.

There are variations of these transducer types Common one is curved linear transducer. Basically i is a linear array transducer with convexity at the anterior part compared to flat scanning surface in linear array transducer.

2) Frequency:- Frequency ranging from 2 to 10 MHz are employed for medical imaging Low frequencies (2-3.5 MHz) of sound wi penetrate well into soft tissues but will no produce image resolution of highest quality So such transducer are commonly used fo examining deeper abdominal/thoraci structures in large or giant breed of dogs High frequencies (7.5 –10 MHz) produc optimal image resolution but are limited i tissue penetration. So it is used for viewin superficial structures. Eg:- eyes.

Basic examination starts with –

- Selection of appropriate part of the body surfac relating to the organ to be scanned.
- Avoid interposition of bone or gas filled structures Once the scanning site has been selected next i the preparation of the site.

1. Skin should be clipped and cleaned with the sprit t

avoid dirt and grease.

2. Apply liberal quantities of acoustic gel. (Purpose of this is to provide better contact)
3. Place the transducer on the skin surface and start examination.(If concentric white lines on the resulting image indicating the poor contact with the skin)

INTERPRETATION OF ULTRASOUND IMAGES

There are certain terms used to describe an image.

a) Echogenic/Echodense / Hyperechoeic — Appears white.

b) Moderately echoeic — Mid to dark grey.

c) Hypoechoeic — Relatively more greyish.

d) Anechoeic / Echolucent –Appears black.

e) Isoechoeic – two adjacent structures having similar density.

IMAGE ARTIFACTS

1) Acoustic enhancement :- An area of increased brightness immediately below a fluid filled structure.

2) Acoustic shadowing: - An area of darkness with no image details immediately below a hyperechoiec surface. Eg;- bone, gas , stones.

3) Mirror image: - It is seen at highly reflective inter phases due to internal reverberation of echoes. Eg;- a mirror image of liver on the other side of diaphragm due to reverberation at the interphase between diaphragm and air filled lungs.

4) Reverberation: - Stream of bright parallel lights seen once again at highly reflective inter phase such as lung / diaphragm inter phase due to reverberation of echoes between the echoes and transducer.

Ultrasonographic examination of various organs

Patient positioning for ultrasonography is important, because it affects the way organs lie within the body cavity. Dorsal recumbency is the ideal patient position for abdominal ultrasound exami-nation. Right and left lateral recumbency can also be used. Lateral recumbency is the preferred position for visualization of thoracic organs. Abdominal organs can be scanned using a 5.0 to 7.5 MHz transducers.

LIVER AND GALL BLADDER

Normal hepatic parenchyma has a uniform echo pattern of low to medium echogenicity. Ultrasonographic assessment of liver size is based on the sonologists experience and it is difficult to measure objectively. The Portal vein(PV), hepatic vein (HV), caudal venacava and the gall bladder are seen as large anechoic fluid filled structures within the hepatic parenchyma. The branches of the portal vein are anechoic with peripheral wall echoes. The caudal venacava also has echogenic walls and the walls of the hepatic veins are usually not seen. The gall bladder (GB) is anaechoic with distal acoustic enhancement. The GB wall appears as a thin echogenic demarcation to the hepatic parenchyma.

Common pathological conditions which can be visualized by ultrasound imaging are hepatomegaly, hepatic lipidosis, cirrhosis, ascites, focal hepatic lesions such as cysts, haematomas, abscesses and hepatic neoplasia and metastasis.

Inflammation of gall bladder wall results in increased echogenecity and thickening of the wall with small echogenic deposits. In acute choleocystitis, the gall bladder contents are anechoic, while chronic disorders produce echogenic particles suspended in the bile fluid.

SPLEEN

Ultrasonography of the superficially located spleen does not require any special preparation. Spleen lies on the left side immediately beneath the abdominal wall, extending from dorsal to ventral. In the dog the transducer is placed directly behind the costal arch. The spleen is scanned in sagittal and transverse planes from the left lateral or ventral abdominal wall. In transverse view the triangular shape with smooth margins. Longitudinally it has a crescent shape. Spleen is more echogenic, than the cortex of the kidney. Spleenic vessels are identified at the splenic hilas region. Diffused as well as focal lesions can be identified by this technique.

GASTROINTESTINAL TRACT

Gastrointestinal morphology and functions are evaluated ultrasonogrpahically by using moderate to high frequency linear, curved array or sector scanners. The amount and type of ingesta determine the outcome of the examination.To

obtain the best results, patients should be prepared correctly for examination. Gastro intestinal air and ingesta is reduced by fasting for 12-24 hrs or by administering gas reducing agents. Oral administration of water is also recommended.

The normal stomach has a five layer appearance consisting of the mucosal interface, mucosa, sub mucosa, mucularis and serosa. Empty stomach appears as 'Cauliflower' like in the ultrasonogrpahic image. Highly echogenic gastric contents usually mask the gastric wall. Under optimal conditions, it is possible to differentiate 5 layers.

Small intestine shows 5 layers in the wall. The presence of fluid, gas and faeces helps to identify the large intestine. The descending colon is found dorsal to the urinary bladder.The colon is visualized as an echogenic interface with a acoustic shadow. Gastrointestinal disorders like gastritis,gastric foreign body,Intussusception, Foreign bodies in intestine etc. can be diagnosed using ultrasound.

During the examination of the pelvic organs,the urinary bladder should be moderately distended with urine . It will serve as an acoustic window to visualize dorsal structures like uterus and colon.

URINARY SYSTEM

Kidneys are located in the retroperitoneal space in the cranial to middorsal abdomen. Right kidney can be visualized using a subcostal approach and left kidney is caudal to the last rib.Renal cortex is a finely granulated ,homogenous and hypoechoic than the parenchyma of adjacent tissues . Renal medulla is more hypoechoic. Diffused and focal diseases of kidneys can be appreciated easily by this technique.

Urinary bladder (UB) is located in the caudal ventral abdomen. Normal urinary bladder contains anaechoic urine.The wall the UB is uniform in thickness and varies with degree of distention.

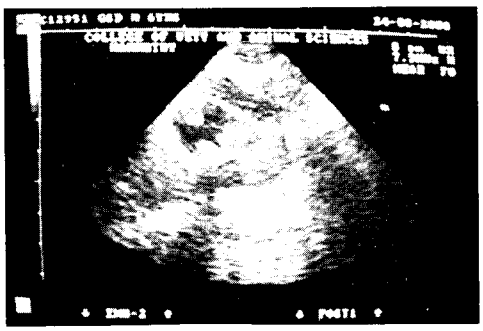
UTERUS AND OVARIES

The body of the uterus is located in the caudal abdomen between the urinary bladder and colon.The wall of the uterus is homogenous with no characteristic layering.The uterine horns are difficult to follow in the absence of pregnancy or pathology.Ovaries may be visualized by imaging the caudal pole of kidney. The ovary is circular to oval in shape.Follicles can be seen as anechoic cystic structures with in the ovary.

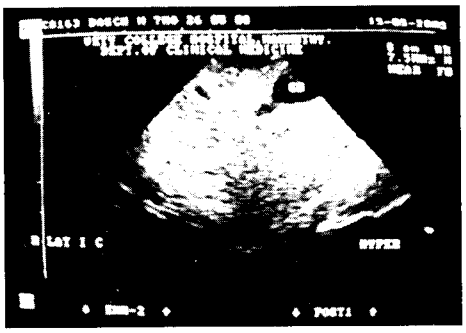
EXAMINATION OF THORACIC ORGANS

Among the thoracic organs this technique is of value mostly for the examination of heart , which is known as echocardiography.Echocardiography provides direct visualization of internal cardiac anatomy , motion and blood flow characteristics.

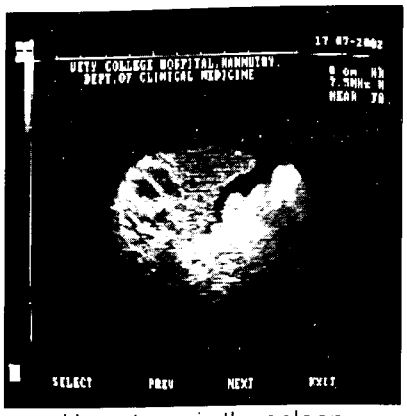
Pathological conditions diagnosed by ultrasonography



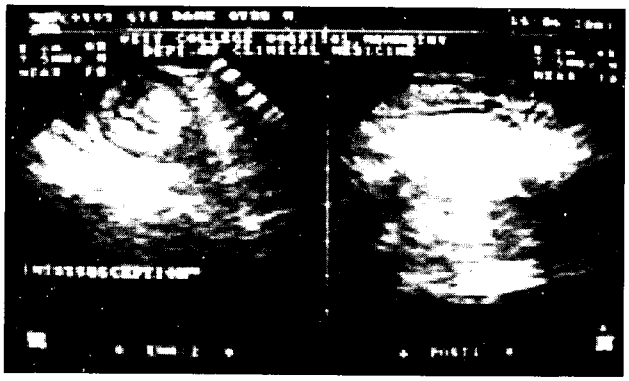
Cholecystitis with hyperechoic gallbladder wall



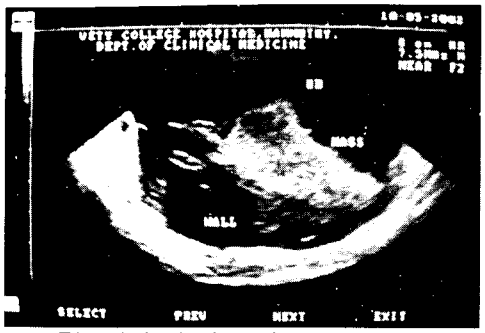
Liver with increased echogenisity



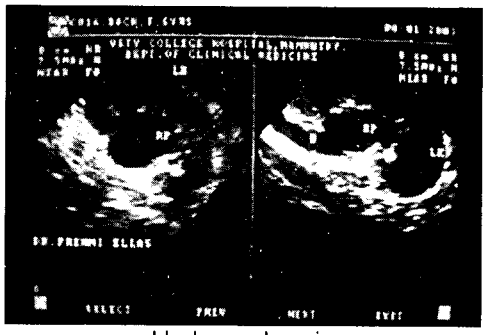
Hematoma in the spleen



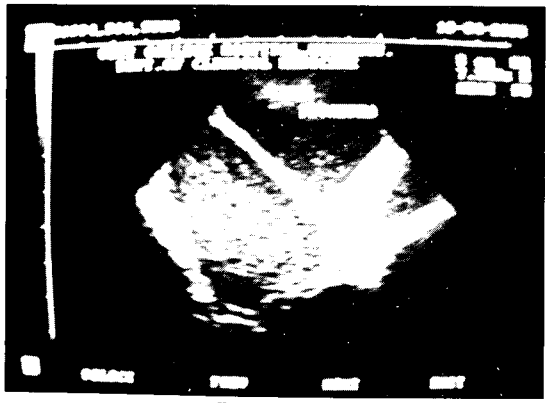
Intussusception (onion skin layering appearance



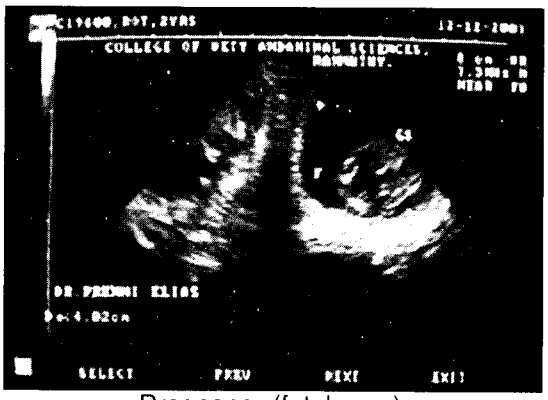
Blood clot in the urinary bladder



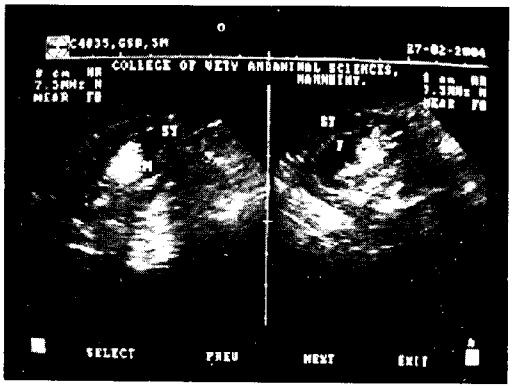
Hydronephrosis



Pyometra



Pregnancy (fetal sacs)



Foreign body in the stomach