Ultrasonography

-Introduction

Real - time ultrasonography(RTUS) has become an essential diagnostic tool as well as a research tool in veterinary sciences because it provides information beyond trans-rectal palpation of the reproductive organs.

Ultrasound is very high frequency (high pitch) sound. Human ears can detect sound with frequencies lying between 20 Hz and 20 kHz. Mechanical vibrations at frequencies above 20 kHz are defined as ultrasound. Medical imaging uses frequencies that are much higher than 20 kHz; the range normally used is from 2 to 15 MHz .The success of **ultrasound** may be attributed to a number of attractive characteristics, including the relatively low cost and portability of an **ultrasound** scanner, the non-ionizing nature of **ultrasound** waves, the ability to produce real time images of blood flow and moving structures such as the beating heart, and the intrinsic contrast among soft tissue structures that is achieved without the need for an injected contrast agent(**non-invasive technique**) . The latter characteristic enables **ultrasound** to be used for a wide range of medical applications, which historically have primarily included cardiac and vascular imaging, imaging of the abdominal organs and, most famously, in utero imaging of the developing fetus. Ongoing technological improvements continue to expand the use of **ultrasound** for many applications, including cancer imaging, musculoskeletal imaging, ophthalmology and others.

The principle underlying the formation of **ultrasound** images is the same as that of underwater **sonar** (**so**und **n**avigation **a**nd **r**anging) used by submarines and fishing boats. It relies on the generation of a short burst of sound and the detection of echoes from reflectors in front of it. The same principle applies when we hear our voices reflected from say, walls, or in tunnels.

Piezoelectric devices

The device that both generates the ultrasound and detects the returning echoes is the **transducer.** Ultrasonic transducers were made possible by the discovery of **piezoelectricity** in quartz by Pierre and Jacques Curie in 1880. **Piezoelectricity** is a reversible property of certain crystalline materials by which a vibration applied to opposite faces of the crystal produces an alternating net electrical charge across the crystal, whereas an alternating voltage applied across the crystal causes it to vibrate in thickness. The transducers used for diagnostic imaging have conventionally been fabricated using the Ferro-electric ceramic **lead zirconate titanate**, which is commonly referred to by the acronym **PZT**, from the first letters

of the chemical symbols for **lead**, **zirconium** and **titanium**. **PZT** provides a relatively high electrical to mechanical coupling efficiency at low cost. Many modern transducers are composites of **PZT** and a non-piezoelectric polymer. The composite materials have lower acoustic impedance than conventional **PZT**, which improves acoustic coupling in the tissue and increases the transducer’s bandwidth.

Therefore, composite materials are now favored for high end clinical systems, where there is less concern about the cost of the transducer. The bandwidth and sensitivity of the transducer are improved by sandwiching the piezoelectric crystal between a backing layer and a matching layer. The purpose of the backing layer is to absorb ultrasound radiated from the back face of the crystal and dampen reverberations within the crystal. The matching layer, which is bonded to the front face of the crystal, serves to reduce the reflection coefficient between the transducer and the tissue, thereby increasing the transducer’s sensitivity to weak echoes.

Description and Practical Recommendations in the Choice of Ultrasound Equipment with a View to Image Quality

Many ultrasound systems are available on the market but not all of them are suitable for use on farm conditions (such as being portable, water proof, robust, strong image quality, comfortable and durable). Therefore, before purchasing an ultrasound scanner, personal needs should be clear and marketing or pricing must not be the key factor in making such an investment – proper use and interpretation of the results shown on the scanner will increase your work efficiency.

Frequency and power of resolution

The frequency represents the number of crystal oscillations per second (number of hertz, Hz) and depends on the crystals characteristics (type and thickness of the matter), where **1MHz** is 1 million cycles per second, **50** times greater than the maximum frequency of audible sound by the human ear — hence the name ***ultrasound***. The high bandwidth probes with a broad - spectrum frequency (from 4 to 8 MHz) emit different frequencies depending on the electrical impulse applied. These probes, like multi-frequency probes with crystals of different resonant frequencies, allow variations in frequency without having to change probes.

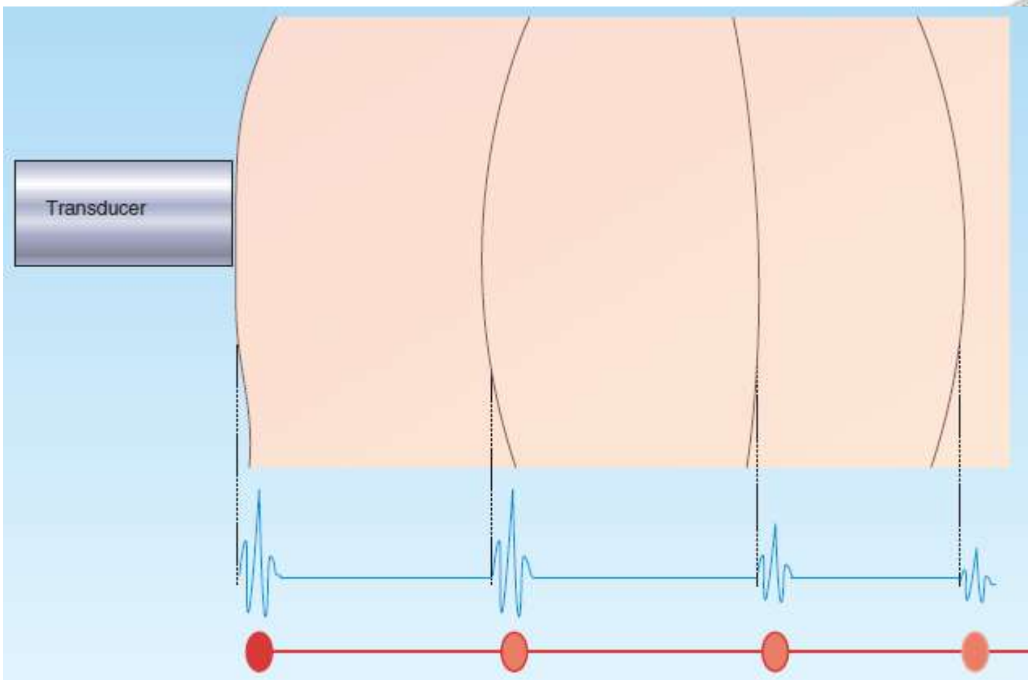

Figure 1. Spot brightness related to echo amplitude.

FLUID = FRIEND

AIR = ENEMY

TISSUE = OK –the smoother the better.

CALCIUM = see to but not through

Probe types

Probes are classified according to whether they provide a linear or sector scan of the tissue section with the ultrasound beam (Figure-2). **Linear scan probes** contain a large number of crystals (**128 – 256**) aligned along the longitudinal axis of the probe over a length of 5 to 15 cm. **Linear scan probes** generate a rectangular - shaped image of constant and sufficient width to cover the region being examined. A larger zone can be viewed if the crystals are placed on a convex surface. This is the case with a convex or curved linear probe that generates an image which could be as large as the one produced by a linear probe at the surface.

Mechanical **sector probes** contain a small number of rotating crystals, a single crystal with an oscillating mirror, or a single oscillating crystal.
Sector probes produce a fan - shaped image that is very narrow at the surface and which expands with depth (Figure -3).

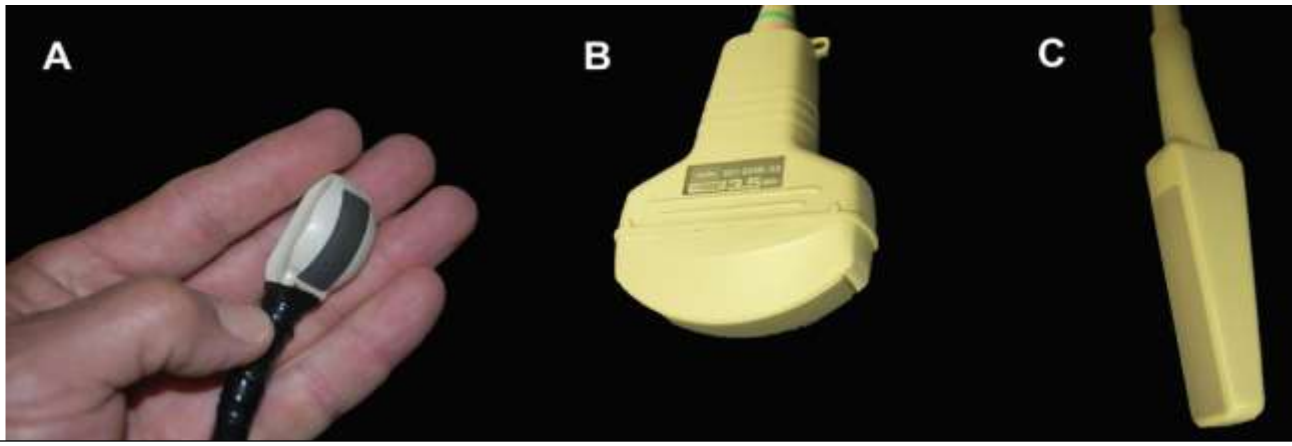

Figure 2. The different types of probes. A: Convex or curved linear probe; B: Sector probe; C: Linear probe

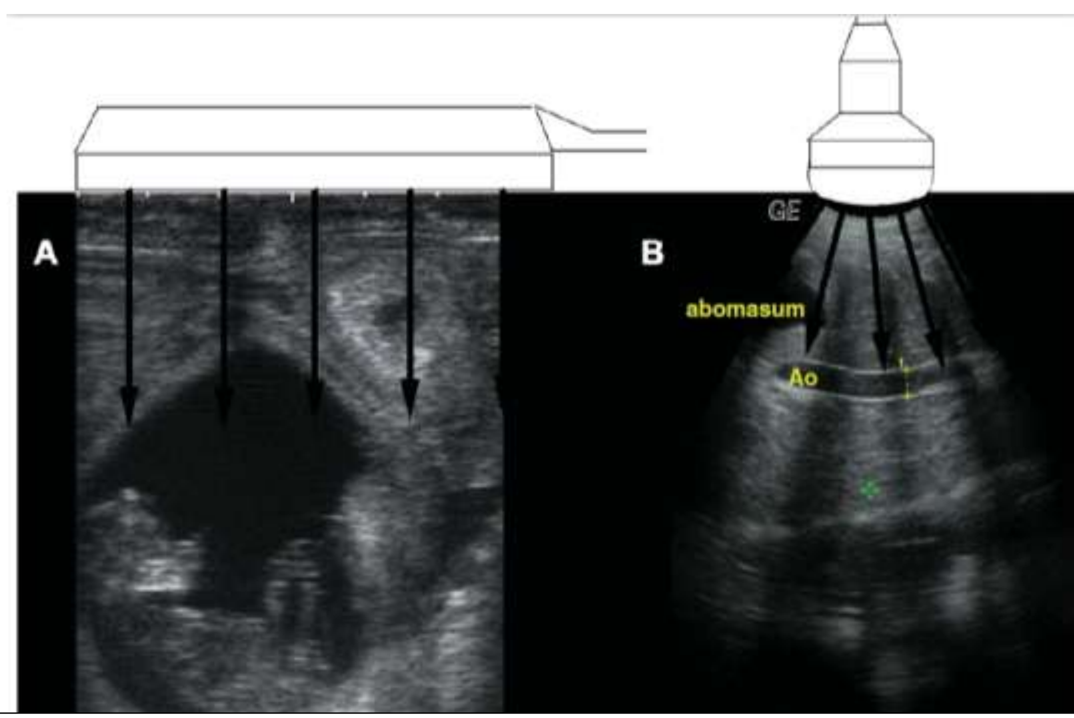

Figure-3. The different probe types and their scanning surface. A: Linear probe; B: Sector probe.