Application of US in large animals

-Equipment and methods to hold the linear probe:-

For reproductive examinations of **cattle** in the field, the 5 MHz linear rectal probe is the most versatile and most commonly used. Some researchers prefer 7.5 MHz to 10 MHz transducers, particularly when studying ovaries or very early pregnancies. As a diagnostic aid **ultrasonography(US)** is well suited for bovine practice, particularly for the examination of female and male reproductive tracts.

*Manipulation of the Probe

Systematic method to scan the reproductive tract

The procedure of **US** examination of the uterus and ovaries is similar to that of a rectal examination . The bovine **ovary** is a fascinating structure that produces a single ovulatory follicle and corpus luteum (CL) at regular intervals. Correct interpretation of the nature of ovarian structures observed by ultrasonography is a complex issue because follicles and CLs are continuously growing or regressing.

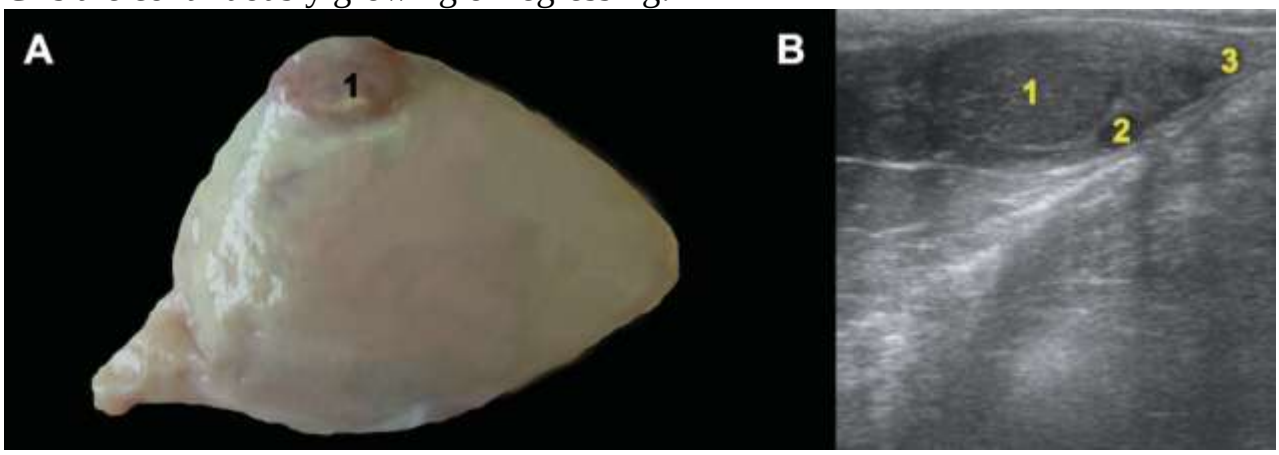


Figure 2-1. Anatomy (A) and ultrasonographic appearance (B) of the ovary with the presence of a mature corpus luteum (7.5 MHz probe; depth of 6 cm). 1: Corpus luteum (2.5 cm); 2: Follicle (4 mm); 3: Posterior pole of the ovary.

*Common Errors:-

1-Manure, gas, or finger interferences

The reading face of the probe must be firmly in contact with the rectal wall. Excessive manure (**Figure 2.2**), gas (**Figure 2.3**), or fingers will interfere with the scan. Gas (reverberation) artifacts are common when a plastic sleeve is used to protect the probe. This can be avoided by putting lubricant inside the sleeve as well as on the outside.

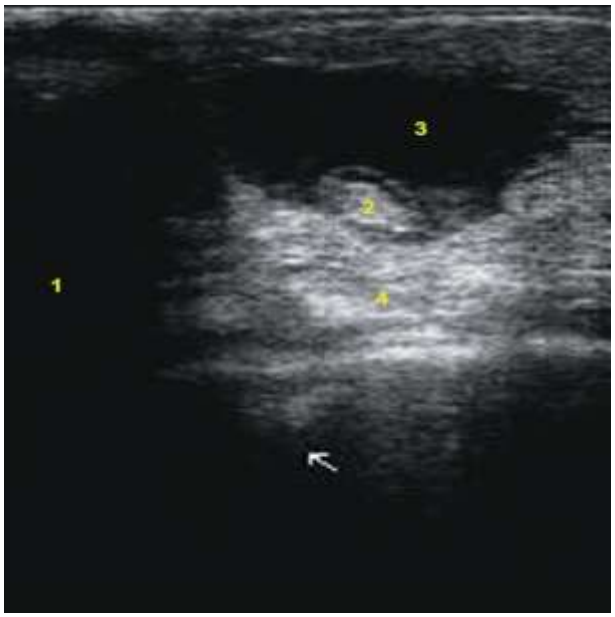


Figure 2.2. Manure interference with image quality (7.5 MHz probe; depth of 7 cm). 1: The dark area on the left side of this image results from poor contact on the probe on the rectal wall, most likely due to manure; 2: Embryo; 3: Allantoic fl uid; 4: Enhancement artifact.

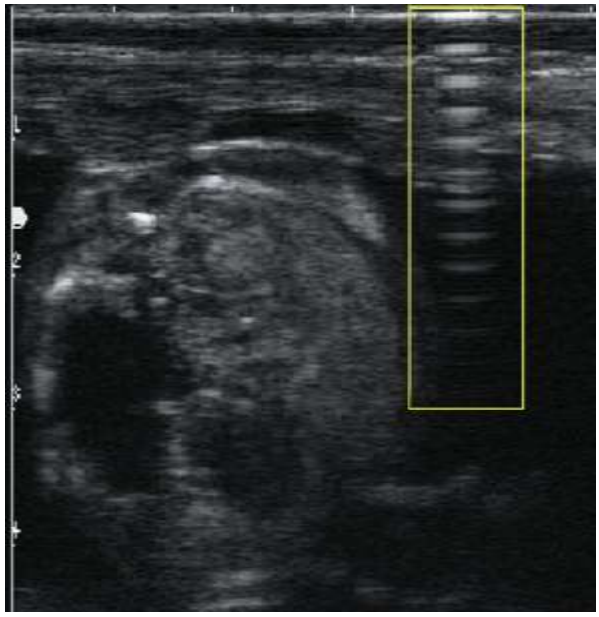


Figure 2.3. Gas interference with image quality produces reverberation artifacts (10 MHz probe; depth of 5 cm). The white half - moon shaped artifacts in the yellow square indicate gas between the face of the probe and underlying structures.

2-Incomplete scan

Incomplete scans can occur when variations of the anatomy of the reproductive tract between animals are not considered. Depending on the age of the cow or the stage of pregnancy, the reproductive tract may be quite deep in the abdomen or completely in the pelvic cavity. Ovaries may be quite lateral to the uterine horns or nearly ventral to them. If the uterus is tightly curled the tips of the uterine horns may be lateral or even beneath the cervix, particularly in young animals. In older animals the uterine horns may extend cranially from the uterine body well into the abdomen.

3-Machine setting

Errors of improper machine settings include gain set too high or low, brightness set too high or low, focal points set at incorrect depths, or too many focal points.

*Ovarian structures

1-Follicles

The follicle can be easily identified on the screen and appears black due to hypoechogenic follicular fluid.The ultrasound appearance of ovarian follicles is shown in **Figure 2-4** .

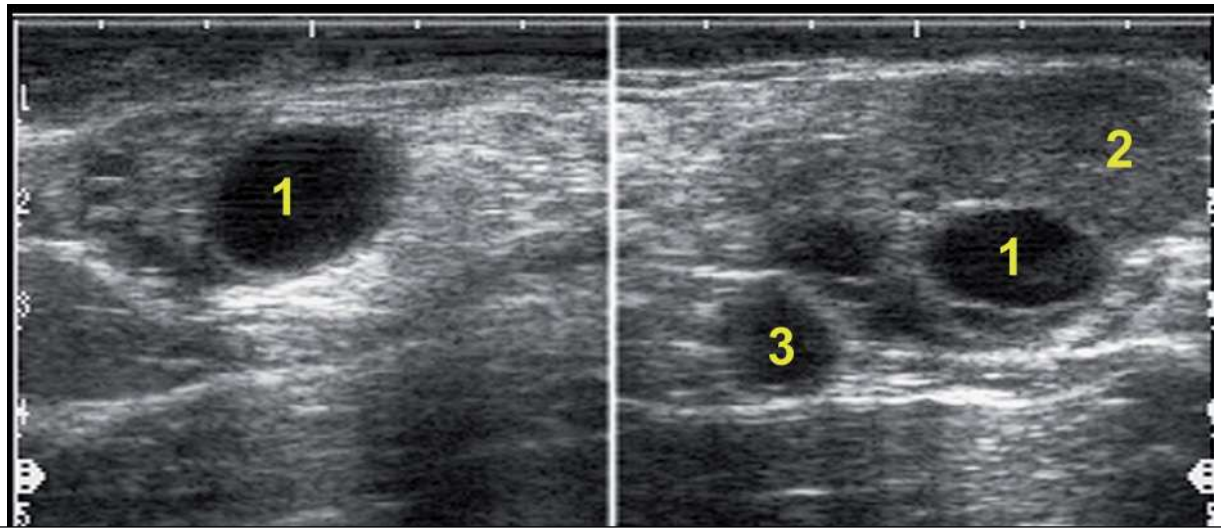


Figure 2.4. Ultrasound images in BB - mode of both ovaries in a cow in diestrus (probe 8 MHz; depth 5 cm). Notice the presence of a single 16 mm follicle on the left ovary. A 2.5 cm CL and an 11 mm follicle are present on the right ovary. **1**: Follicle; **2**: Corpus luteum (CL); **3**: Blood vessel.

During the ultrasonographic evaluation of the ovaries, it is important to be able to distinguish a follicle from a blood vessel. A cross – sectional view of an ovarian blood vessel resembles the image of a spherical segment of a follicle. However, when moving the probe in the direction that will allow a longitudinal section rather than a cross section of the blood vessel, the initial spherical image will become elongated, contrary to the follicle, which becomes a smaller sphere and simply disappears from view when the probe is moved away.

Due to the continuous production of follicular waves throughout the estrous cycle, large follicles > 8 mm are always present in bovine ovaries (except for the first few days of the cycle), and thus it can be misleading to attempt to predict the time of ovulation based solely on the size of the largest follicle. We therefore need to rely on other signs, such as changes in ultrasound echogenicity of the uterine wall and CL, increased uterine tone, the presence of endometrial secretion within the uterus, the presence of cervical mucus, and the cow ' s behavioral changes

2-Corpus luteum

In bovine reproduction, it is very important to be able to recognize the presence of the corpus luteum (CL). The presence of a CL confirms that a heifer has attained puberty. Localization of the CL on the left or right ovary can indicate to the practitioner in which uterine horn the presence of an embryo or fetus needs to be confirmed for pregnancy diagnosis.

The mature **CL** is hypoechogenic (darker) compared to the ovarian stroma due to extensive vascularization. Echographically we can distinguish differences between a mature compact corpus luteum and a mature cavitary corpus luteum (**CCL**) **Figure 2-5.**.

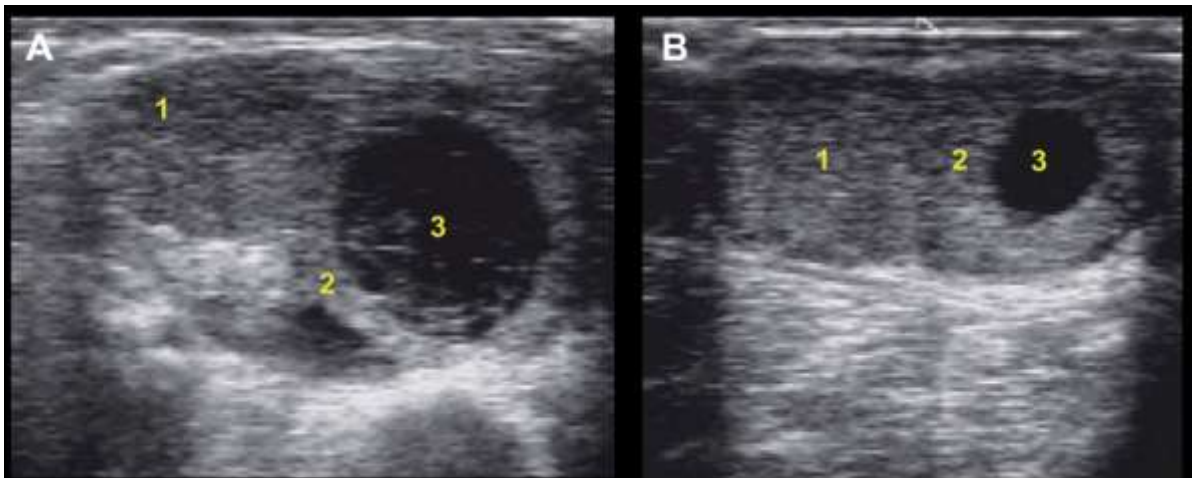


Figure 2.5. Ultrasonograms of two ovaries that present cavitary and compact corpora lutea (**CL**) in the same ovary. **1**: Compact CL; **2**: Luteal tissue of a cavitary CL (**CCL**); **3**: Cavity of a CCL. Echogenic fibrin strands are also observed in the cavity of the CCL (**A**).

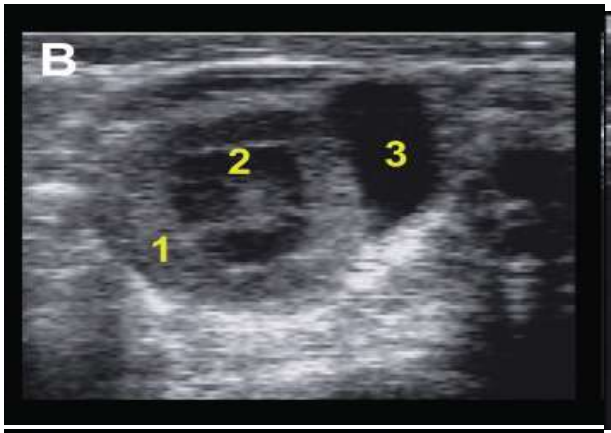
-Filling of the cavity can take many different forms:

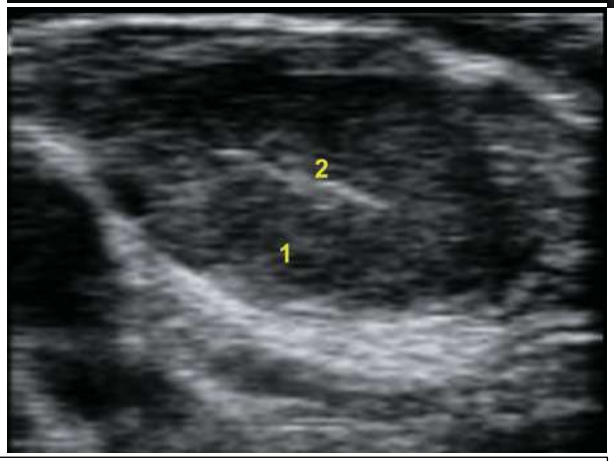
1. In some cases, uniform hyperechogenic tissue completely fills the cavity. The exact nature of this tissue is unknown but might be due to specular reflexions of new luteal tissue intermixed with fibrin strands, which are known to be very echogenic.

2. In some cases, the filling of the cavity occurs gradually and can be partial or complete.

3. The cavity can be completely substituted by luteal tissue leaving only a hyperechogenic line or scar (**Figure 2-6**).

4. The cavity stays but an evident hyperechogenic ring appears surrounding the same cavity (**Figure 2-7**).





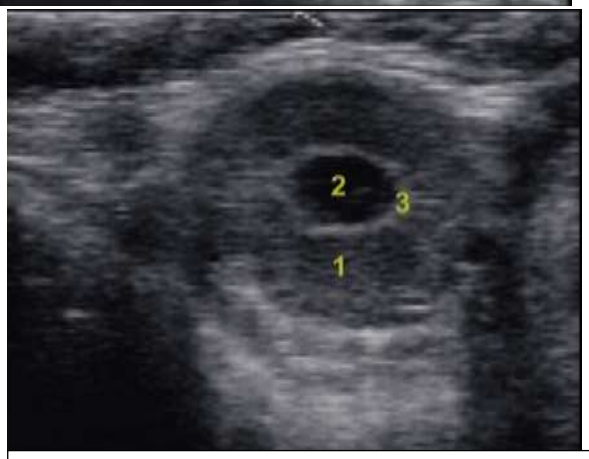


Figure 2-6. Cavitary corpus luteum in which the cavity was replaced by white hyperechogenic line or scar at approximately 10 days of the estrous cycle (7.5 MHz probe; depth of 4.5 cm). 1: Luteal tissue; 2: Central scar.

Figure 2-7. Cavitary corpus luteum in which the cavity is surrounded by a hyperechogenic ring (7.5 MHz probe; depth of 4.5 cm). 1: Luteal tissue; 2: Cavity; 3: Hyperechogenic ring.

* Ultrasound of the Uterus during the Estrous Cycle and Normal Postpartum Period In Bovine:

During this period (– 3 days to +4 days from estrus), which is characterized by a high level of circulating estrogen, the cervix partially opens, the uterus has increased tone, its walls are thicker, and the apex of the uterine horns unfold or are longer than during diestrus, On the ultrasound monitor these physiological phenomena translate into less uniform gray tones or more heterogenicity as well as a swollen or swirled appearance of the uterine wall. There are also more areas of the uterus showing dark, anechogenic zones that denote areas of edema and increased vascularity under the endometrium.

Figure 2-8. Ultrasonogram of two edges of a uterine horn in transverse section in a cow during estrus (probe 8 MHz; depth 4 cm). Note the considerable accumulation of endometrial mucus in the lumen of the uterus and the typical swollen appearance of the uterine wall in periestrus. 1:Endometrium; 2: Myometrium; 3: Vascular portion of the uterus; 4: Lumen of the uterus containing mucus; Arrowheads: Edge of the uterus.

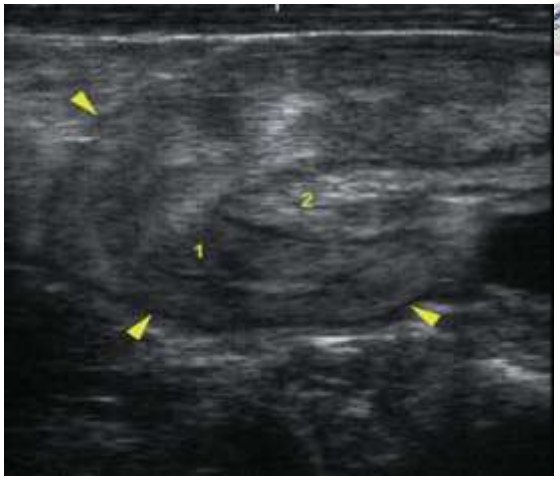


Figure 2-9. Ultrasonographic image of a longitudinal section of the uterine horn (probe 8 MHz; depth 6 cm). 1:Endometrium; 2: Myometrium; Arrowheads: Edge of the uterus.

Diestrus

During diestrus the circulating progesterone levels bring the uterus back to a state of calm, preparing it for the implantation of an embryo if fertilization occurred during estrus. The uterus loses its tone, becomes thinner and normally loses the endometrial liquid. Figures-2-10, show the normal ultrasound appearance of the uterine horns during diestrus.

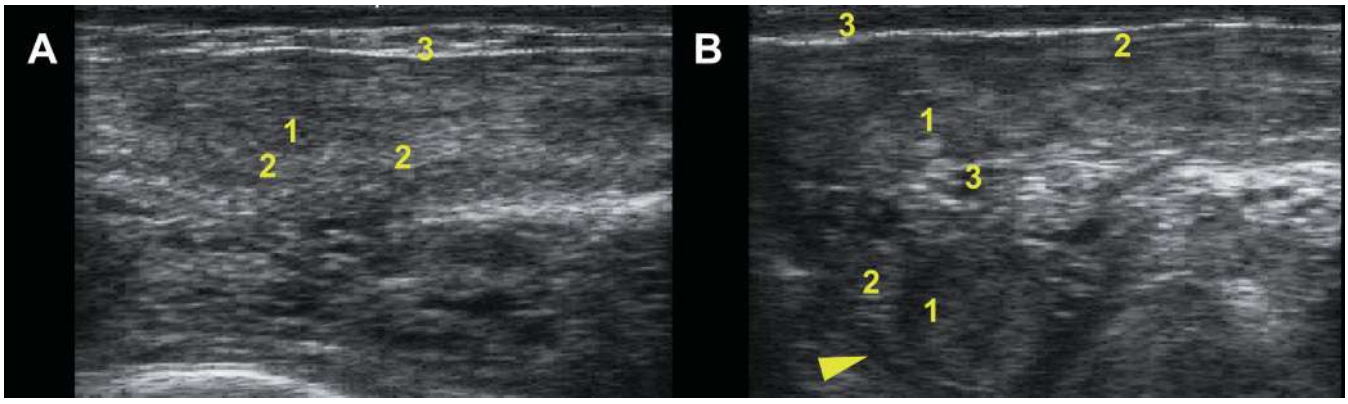


Figure 2-10. Sonograms of longitudinal sections of uterine horns during diestrus at day 8 (A) and day 11 (B) of the estrous cycle (probe 8 MHz; depth 4.5 cm). Note the reduced distinction between the endometrium and the myometrium in diestrus compared to periestrus in Figures 5.4 B and 5.5 B. B: In this ultrasonogram a transverse cut of a portion of the uterine horn (arrowhead) can also be visualized under the longitudinal section of the uterus. 1: **Endometrium**; 2: **Myometrium**; 3: Edge of the uterus; Arrowhead: Transverse section of the uterus;

Normal appearance of the gravid uterus and the <u>Bovine</u> conceptus during early stage of gestation:

Early ultrasound diagnosis of gestation reveals a uterine lumen containing a variable quantity of anechogenic fluid produced by the conceptus . Fluid accumulation and uterine distension depend largely on the stage of gestation and the age of the cow. It is sometimes difficult to locate the embryo in the slight quantity of amniotic and allantoic fluid before day 30 of gestation , because the young embryo is often lodged close to the uterine wall and may even be concealed by an endometrial fold . Careful examination in the zone of anechogenic fluid generally reveals the presence of the embryo close to the uterine folds. Starting on day 30 it is also possible to view the echogenic amniotic membrane that produces specular reflections due to its round shape (Figures 2.11).

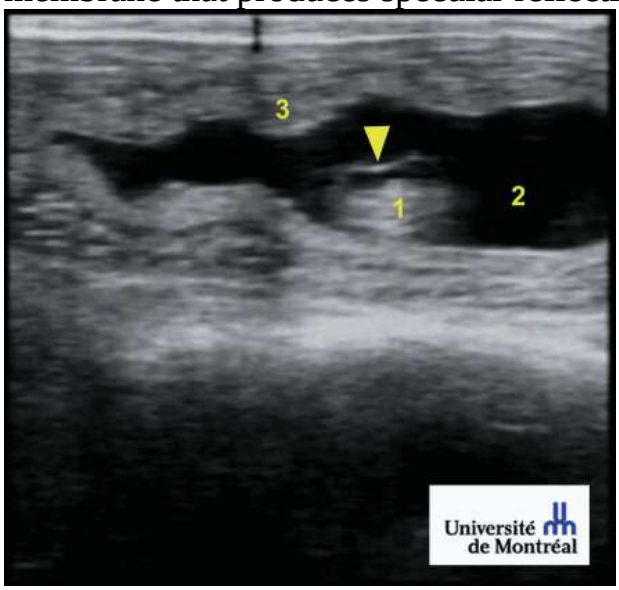
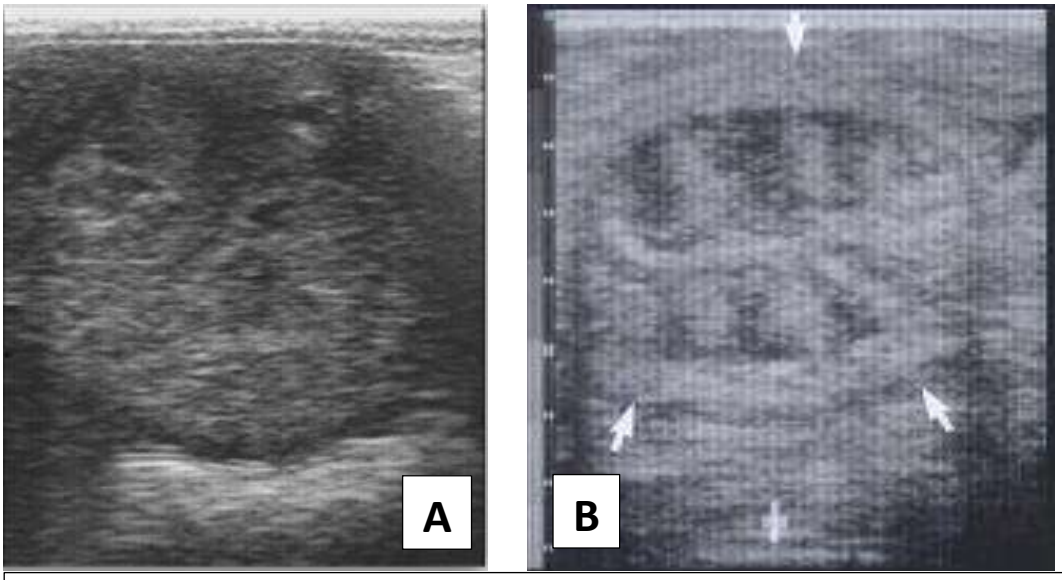


Figure 2-11. A 30 - day - old embryo measuring 12 mm is located close to some uterine folds that are the same size as the embryo (7.5 MHz probe; depth 6 cm) . There is a smaller quantity of amniotic fl uid compared to the allantoic fl uid. 1: Embryo; 2: Allantoic fl uid; 3: Uterine fold; Arrowhead: amnion.

Estimating the Stage of the Estrous Cycle in <u>Mares</u> by Uterine Characteristics:

Uterine echotexture can be used to differentiate diestrus (i.e., the luteal or progesterone-dominated phase of the estrous cycle) and estrus (i.e., the follicular or estrogen-dominated phase of the estrous cycle). The diestrus uterus is characterized by a relatively *homogeneous echotexture*. The uterine lumen and endometrial folds are not discernible during diestrus.

During estrus, the endometrial folds become prominent and the uterus has a very *heterogeneous appearance* (i.e., a mixture of hyperechoic and hypoechoic areas). This ultrasonic pattern results from edema within the endometrium and, occasionally, free fluid within the uterine lumen. A characteristic “cart-wheel” pattern may be evident in cross-sectional images of the uterine horns of mares in estrus (Figure 2-12).



Fig,2-12-Ultrasonographic image of a cross section of a uterine horn of a mare in diestrus**(A)** and estrus **(B)**