The ultrasonographic diagnosis of pregnancy in the dog and cat

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The normal ovaries and uterus

The ovaries are either directly caudal, or caudal and medial, lateral or ventral to each respective kidney. The normal ovary is small (canine: 1.5 x 0.7 x 0.5 cm) and may be hypoechoic, or have anechoic follicles (normal size is up to 1 cm) within it. After ovulation, the follicles do not collapse, but develop an initial mixed echogenicity, progressing to a hyperechoic then hypoechoic corpus luteum, which produces progesterone. Ovarian neoplasia can occur and is suspected when a mass is seen just caudal to one of the kidneys.

The normal uterus is difficult to visualize in the dog (normal size 0.5 – 1 cm), and usually not visualized in the cat. A full urinary bladder provides a good acoustic window. The body of the uterus lies dorsal to the bladder and ventral to the colon, and is either close to the midline, or just to one side of it.   The uterine horns are difficult to visualize unless they are enlarged. The normal uterine lumen is usually not distinguishable.

Pyometra in the dog and cat

Cystic endometrial hyperplasia can develop in both dogs and cats, though it is seen more often in dogs, and this condition can contribute to infertility. It is generally not associated with other clinical signs, and thus may be an incidental finding during an abdominal ultrasound exam. Ultrasonographically, cysts are seen within the uterine wall, and a small amount of intraluminal fluid may be present. When a significant amount of mucoid fluid builds up in the uterine lumen, the condition is termed mucometra. Pyometra develops when bacterial infection develops within the abnormal uterus. Pyometra can be 'open', with the cervix open and vaginal discharge present, or 'closed', when the cervix is closed and no vaginal discharge is present. The classic time pyometra is diagnosed is two months after the dog is in heat. Ultrasonographically, a pyometra will appear as a fluid-filled uterus. The fluid may be anechoic, but often will have echogenic particles within it. The uterine wall may initially be edematous and thickened, but with increasing uterine distension, it can become very thin. Fine-needle aspiration of uterine contents is NOT recommended.

Severe systemic illness can develop in animals with a closed pyometra, and an emergency ovariohysterectomy is often indicated once the diagnosis is made (Old practice saying is: "Never let the sun set on a pyometra"). In some cases of pyometra, medical therapy with prostaglandins, dopamine agonists and antibiotics can be attempted when the dog is intended for future breeding. Condidates for medical treatment should not be ill, should be less than 6 years old, and should have an open cervix. There should not be evidence of thin uterine walls or free abdominal fluid. Medical therapy should continue until fluid can no longer be seen within the uterine lumen, which usually takes between 5 and 21 days. The first recheck is done at 5 days, and then every 2 days until the fluid is gone. The dog should be bred at the next cycle, keeping in mind that she still has cystic endometrial hyperplasia and may not get pregnant. Typically, she would be spayed after the next litter of puppies is born.

In spayed dogs, a 'stump' pyometra can develop within the uterine stump. Radiographs may not detect this condition. Ultrasonographically, a large, complex mass may be seen just cranial to the pubis between the bladder and the colon.

Pseudopregnancy
Dogs, and more rarely cats, can exhibit signs of a pseudo, or false pregnancy 6 -12 weeks post estrus. This state can be clinically unapparent, or signs seen can include weight gain, mammary gland hyperplasia and lactation, mucoid vaginal discharge, inappetance, restlessness, nesting and mothering of inanimate objects. The importance of this condition is to know that all animals exhibiting the above symptoms or behaviors are not necessarily pregnant.

Gestational age defined
In the dog, pregnancy does not necessarily begin on the day of mating. During the canine reproductive cycle, estrogen peaks followed by the luteinizing hormone (LH) peak 1-3 days later. Ovulation occurs 1-3 days after the LH peak. The dog is in estrus or 'heat' starting at the LH peak or several days before or after, estrus lasts for 5-9 days, breeding may occur on multiple days, and the male's sperm is fertile for 4-6 days. All of these factors result in an uncertain conception date, and thus variable gestation length (56-72 days) when counting after the breeding date. Canine gestation length is fairly consistent (65 ± 1 days) when counting after the LH surge. Assessment of gestational age ultrasonographically is thus defined in relation to days after the LH peak. In the cat, conception takes place shortly after breeding, and their gestational age is 61 ±1 days. Cat's ovarian activity is influenced by the photoperiod. Ovulation in the cat is usually induced by breeding, but can be spontaneous. Often, without ovulation or pregnancy, a cat will cycle every 10-14 days.

Methods of pregnancy diagnosis

No blood or urine test exists to confirm pregnancy in the dog or cat. Pregnant dogs and cats are typically not hormonally distinct from non-pregnant animals in the post estrus period. Dogs and cats do not have an estrus cycle every 3-4 weeks like humans do, thus they cannot be observed for a 'missed' cycle. Methods of pregnancy diagnosis used include abdominal palpation, radiography and ultrasound.

Abdominal palpation: At approximately 28 days post LH peak in the dog (range 21 to 35 days) and 30 days post breeding in the cat, the individual gestational sacs can be palpated. As the uterus gets larger, the individual sacs can no longer be differentiated. The large uterus can often still be palpated, but pathologic conditions of the uterus cannot be distinguished from pregnancy.

Radiography: Litter size can be most accurately predicted radiographically (93% accurate). At approximately 45 days post LH peak in the dog and 36-45 days post breeding in the cat, fetal mineralization can be seen radiographically. Possible reasons for missing a diagnosis of pregnancy radiographically include masking by overlying viscera with ingesta, underexposure and scant fetal mineralization. The fetal skeletons must be seen to confirm pregnancy. An enlarged uterus could be due to disease such as pyometra.

Ultrasound: Ultrasound is an excellent way to determine if an animal is pregnant, if the fetuses are viable and what the gestational age is. Ultrasound generally is not an accurate method of determining litter size. Fasting the patient before the pregnancy check ultrasound exam is often not necessary. Breeders should be informed ahead of time that the animal will be shaved, as some will object to this. I usually begin the exam in the caudal midabdomen, imaging the urinary bladder first, then examining dorsally for the uterine body. I will then follow the left uterine horn cranially, then proceed to follow the right uterine horn caudally. The uterine horns bend in multiple directions rather than lie in a straight line when a large litter is present, and fetuses can be seen literally 'everywhere' in the abdomen. In this situation, a systematic approach to view every fetus, but each fetus only once becomes challenging.

Ultrasound is a very sensitive and specific imaging method to diagnose pregnancy if it is performed at least 30 days after breeding in the dog and at least 16 days after breeding in the cat. Pregnancy has been diagnosed as early as 10 days after breeding in the dog and 11 days after breeding in the cat. False negative exams can occur due to overlooking a fetus, which could happen due to gas or fecal material creating shadows. False positives could occur due to viewing a loop of small intestine, but most of the time imaging in a second plane reveals that intestine becomes tubular, whereas a gestational sac does not. Visualization of a gestational sac is considered to confirm pregnancy. Uterine enlargement will precede the formation of the gestational sac, but that is not a specific finding. Cardiac activity and fetal movement are predictable signs of fetal viability. Visualization of the embryo and cardiac activity usually occur on the same day. Initially, cardiac activity appears as a flutter within the embryo tissue. The fetal heart rate is usually twice the maternal heart rate, and usually is between 200 and 220 beats per minute (bpm). Fetal activity can include swallowing, hiccoughs, and body and limb movements.

One can predict gestational age can by assessing for the presence of fetal structures (See Tables 1 and 2) as well as measuring the gestation sac (GSD), crown-rump length (CRL), and head diameter (HD) and body diameters (BD) of the fetus (See Tables 3 and 4). The timeline of appearance of fetal structures is constant between breeds, and these observations should always be used along with the measurements that are taken to most accurately predict gestational age. When obtaining measurements, at least two fetuses should be used. In dogs, the accuracy of measurements (using GSD, CRL or HD) is best at 30 days post LH peak. The accuracy is not affected by litter size, but in toy and miniature breeds (≤ 9 kg), one day should be added to the calculated gestational age. In giant breeds (> 40 kg), two days should be subtracted from the calculated age. In the last 3 weeks of gestation, the accuracy falls to about 50%, and the head diameter measurement should be used as it is the most reliable. Overall, the accuracy of prediction of gestational age at any time during gestation, once adjusting for body weight as described above, is 87% ± 2 days from the predicted age.

Fetal number cannot be accurately judged with ultrasound.
A reason for this could be that only a small section of the reproductive tract can be imaged at one time, allowing fetuses to be counted more than once or not at all. Fetal resorption may also be a factor. The tendency is to overestimate the size of small litters, and underestimate the size of large litters. One can probably say it is a 'small litter' or a 'large litter', but otherwise the accuracy is very poor (one study quoted 18% from 30-50 days, and only 8% when done after 50 days). Many veterinarians and clients are not aware of this limitation of ultrasound, thus they are expecting to get a fetal number along with the diagnosis of pregnancy and prediction of gestational age. I generally tell clients, "The litter size will probably be whatever I count, plus or minus 5", and that seems to get the point across.

Pregnancy abnormalities
When a fetus dies before 25-35 days post ovulation, resorption usually occurs. The resorption rate of the entire litter has been reported to be 11% in dogs. Approximately 5-13% of dogs may resorb one or more fetuses, but carry the rest to term. When fetuses die after 35 days, they are usually aborted. Signs of fetal death include increased echogenicity of the embryonic fluid, loss of cardiac activity, loss of fetal activity, loss of detail of fetal structures, collapse of the conceptus and uterine wall and intrauterine or fetal gas (not to be confused with overlying intestinal gas).

Ultrasound can be used to monitor fetal development. The canine embryo grows 1 mm per day from 17 to 30 days post LH peak, after which the growth is exponential. If growth is slow, or development of a fetal structure is not observed 2 or more days after it is expected, the fetus has a greater chance of being resorbed or aborted. Fetal congenital abnormalities have been infrequently reported in veterinary medicine. Fetal stress due to hypoxia, such as might occur during dystocia, is manifested as a slowing of the heart rate. Fetal distress is severe if the heart rate drops below 180 bpm.

The ultrasonographic appearance of the post partum uterus has been described, but evaluation of uterine involution is rarely indicated in a standard practice. The appearance of a retained placenta has not been described, and the placenta would most likely blend into the uterine wall and other luminal contents. Sub-involution of placental sites occurs in the dog, but the ultrasonographic appearance of this has not been described.

Table 1. Timing of recognition of canine fetal structures (from Mattoon and Nyland, 2002).

Fetal structure	Days post LH Peak	Days before parturition
Gestational sac	20	45
Embryo	23-25	40-42
Cardiac activity	23-25	40-42
Yolk sac, U shaped	25-28	37-40
Yolk sac, tubular	27-31	34-38
Fetal orientation (head and body)	28	37
Limb buds, fetal movement	35	30
Fetal skeleton	33-39	26-32
Stomach, urinary bladder	35-39	26-30
Lungs: hyperechoic vs. liver	38-42	23-27
Kidneys, eyes	39-47	18-26
Cardiac chambers	40	25
Intestines	57-63	2-8

Table 2. Timing of recognition of feline fetal structures (from Davidson et al., 1986).

Structure	Days post breeding	Days before parturition
Uterine enlargement	4-14	47-57
Gestational sac	11-14	47-50
Fetal pole (echogenic linear density)	15-17	44-46
Cardiac activity	16-18	43-45
Fetal membranes	21-24	37-40
Fetal morphology	26-28	33-35
Fetal movements	28-30	31-33

Table 3. Fetal structure measurements (from Kutzler et al., 2003).

Measurement	Details
Gestational sac diameter (GSD)	Anechoic space is measured. Average two dimensions taken at 90º.
Crown-rump length (CRL)	Days 26-29: Total length. After day 30: Most rostral crown to base of tail.
Head diameter (HD)	Days 30-35: Same plane as CRL. Measure outside edge. After day 35 (skeleton seen): Biparietal diameter
Body diameter (BD)	Days 26-29: Same plane as CRL After day 30: Transverse plane at level of liver/stomach Average two dimensions taken at 90º.

Table 4. Formulas to predict gestational age (GA) and days before parturition in the dog and cat (from Mattoon and Nyland, 2002 and Zambelli, 2002;
GSD=gestational sac diameter; CRL=crown-rump length; HD=head diameter; BD=body diameter; GA=gestational age.

Dog (± 3 days)	Cat (± 2 days)
Less than 40 days (measurements in cms): (6 x GSD) + 20 (BEST) (3 x CRL) + 27	Less than 30 days (measurements in mms): (1.0901 x GSD) – 0.9372 (1.0099 x CRL) – 0.03378
More than 40 days (measurements in cms): (15 x HD) + 20 (BEST) (7 x BD) + 29 (6 x HD) + (3 x BD) + 30	More than 40 days (measurements in cms): (25 x HD) + 3 (11 x BD) + 21
Days before parturition 65 - GA	Days before parturition 61 - GA

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