FETAL COUNT RADIOLOGY

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Fetal count radiographic procedures are commonly performed in veterinary medicine. These studies take place late in an animal's pregnancy, and allow the veterinarian or veterinary technician to count the number of fetuses present.

It is often essential for breeders and pet owners to accurately assess the number of fetuses present prior to whelping. An accurate fetal count:

- Facilitates treatment in cases of fetal retention (dead fetus)
- Allows for early intervention in cases of dystocia.

Although these procedures are valuable when planning whelping, breeders and pet owners have questioned the safety of this procedure with regard to the risks associated with radiation-induced carcinogenesis.

WHY NOT ULTRASOUND?

In human medicine, fetal assessment is done by diagnostic ultrasound. However, the majority of experienced radiologists agree that diagnostic abdominal ultrasound is a poor predictor of fetal counts in species that bear litters.[1]

Ultrasound is inaccurate for assessing fetal number because:

- Only a small portion of the uterus is imaged in one scanning plane
- Fetuses may be counted more than once or not counted at all.

Because of these limitations of ultrasound, radiographic evaluation is the only practical and readily available method of fetal counting in veterinary medicine.[2]

UNDERSTANDING RADIATION EXPOSURE

In order to understand the risks associated with fetal radiation exposure, the veterinarian and veterinary technician must have a working understanding of the amount of radiation used during a fetal count procedure. However, the units used to describe radiation exposure can be confusing.

For this discussion, all units will be converted to *millirem* (mrem). This unit of radiation exposure is the one most familiar to veterinary team members. As you consider the risks and benefits of fetal count imaging, keep in mind that the exposure from a single lateral radiograph of the abdomen, estimated from exposures described in human medicine, is 30 to 50 mrem.

FETAL COUNT RADIOLOGY RISKS

Mutations & Miscarriage

Noncarcinogenic effects of radiation on the fetus vary with gestational age and radiation dose.

Gestational Age. In humans, embryonic death and congenital malformations most likely occur as a result of radiation exposure during the first 6 weeks of pregnancy. Therefore, in humans, embryonic death typically takes place during the preimplantation period (0–9 days), while malformations usually occur during organogenesis (10 days–6 weeks). Effects on the central nervous system occur early in the fetal period (6 weeks–term), with a peak sensitivity at 8 to 15 weeks.

Radiation Dose. Although we do not have data for canine patients, in human medicine:

Figure 1. *This image shows a pregnancy complication—gas in the uterus and a macerated fetus.*

- The Health Physics Society states that the level of radiation exposure used in most diagnostic procedures (< 5 rads or 5000 mrem) will not increase noncarcinogenic reproductive risks (birth defects or miscarriage) during any stage of gestation in humans.[3]
- According to the U.S. Nuclear Regulatory Commission, the maximum permissible dose limit to a human embryo/fetus is:
  - » 500 mrem within 9 months
  - » Maximum of 50 mrem per month.

  Doses below those outlined above are considered an acceptable radiation exposure dose for a human embryo/fetus.[4]
- The Centers for Disease Control and Prevention (CDC) recommend that radiation-induced noncarcinogenic health effects are unlikely in humans, below approximately 0.50 Gy (50 rads or 50,000 mrem) from 16 weeks gestation to birth.[5]

This information demonstrates that the radiation exposure from a single lateral projection of the abdomen (≈ 30–50 mrem) is far less than 50,000 mrem and, therefore, a fetal count evaluation carries little risk of noncarcinogenic side effects (developmental abnormalities or miscarriages) to the fetus when performed late in pregnancy.

Carcinogenesis

Although no data are available for canine patients, the CDC reports that, in humans, the:[5]

- Estimated childhood cancer incidence in patients exposed to radiation during diagnostic radiographic procedures (0–5 rads or 0–5000 mrem) is 0.3% to 1%
- Estimated lifetime cancer incidence for these same patients is 38% to 40%.

It is important to note that the:

- Estimated childhood cancer incidence in humans not exposed to radiation (above background radiation levels) is 0.3%

TIPS FOR ACCURATELY ASSESING FETAL COUNT

Tip 1. Obtain radiographs on or after day 55 of gestation. A major pitfall of fetal counting is obtaining radiographs before fetuses are fully mineralized.

Tip 2. Use the lateral projection for fetal count evaluations. In most cases, the lateral projection provides the best visualization of the fetuses; the ventrodorsal projection requires more skilled radiographic technique due to greater thickness of the projection, which can create scatter and decrease contrast, making fetal counting difficult.

Tip 3. Count heads. Count spines. If they do not match up—count again. A large number of fetuses in the abdomen can make it extremely difficult to keep track of them. Therefore, if the 2 numbers match, you counted correctly. If they do not match, you either missed a fetus, counted a fetus twice, or there is a problem with the fetus.

- Estimated lifetime cancer incidence in humans not exposed to radiation is 38%.

Therefore, human patients exposed to low levels of radiation in utero have only a small increase (< 1%) in the incidence of childhood cancer and small increase (< 2%) in the incidence of lifetime cancer.

In addition, the high end of the range used to make the above estimates (5000 mrem) far exceeds the exposure from a single lateral radiographic projection of the abdomen (50 mrem). Unfortunately, we do not have data evaluating the cancer risk in dogs (or humans) from a single lateral projection of the abdomen.

RISK VERSUS BENEFIT

Given that all radiation exposure should be considered potentially harmful, a risk/benefit analysis must be performed prior to obtaining a fetal count study, and the benefits of obtaining the study must outweigh the risks associated with fetal exposure.

In veterinary medicine, we do not have a cost effective or efficient method to determine fetal number without using ionizing radiation. As stated previously, diagnostic ultrasound is poor at predicting fetal number in litter-bearing species.

For many breeders and pet owners, the benefit of knowing the number of fetuses prior to whelping outweighs the risk of exposing fetuses to ionizing radiation.

FETAL COUNT RADIOLOGY GUIDELINES

- **Perform a risk/benefit analysis** prior to obtaining a fetal count radiographic study.
- **Discuss with clients the risk/benefit analysis** of performing a fetal count study prior to obtaining the radiograph
- **Advise clients that:**
  - » All radiation is potentially harmful
  - » Our understanding of the risks associated with fetal radiation exposure is largely based on correlates in other species rather than direct research in canine or feline patients.
- **Limit radiation exposure to the fetuses** because all radiation is potentially harmful. Only perform fetal count studies if clinically indicated and at a time during pregnancy the study is most likely to be accurate, which avoids the need to repeat radiographs if the initial set was obtained too early during pregnancy.
- **Advise technicians to only obtain a single lateral projection.** A ventral dorsal projection may be necessary in some cases to assess:
  - » Fetal health
  - » Fetal positioning in relation to the pelvic canal
  - » Fetal number if there are difficulties assessing fetal number based on lateral projection.

However, discourage orthogonal projections and/or repeat projections to obtain perfect positioning or exposure.

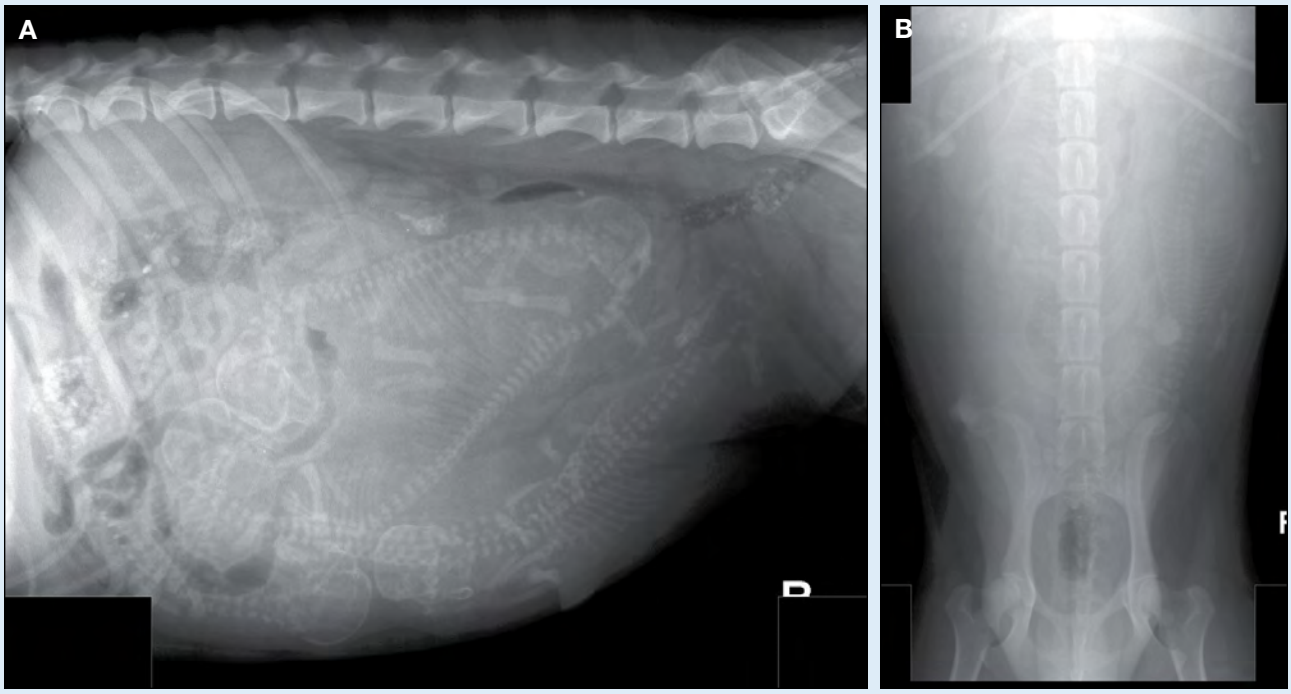

Figure 2. *Lateral (**A**) and ventrodorsal (**B**) radiographs of a normal pregnancy; note that it is easier to identify the bones in the lateral than the ventrodorsal radiograph.*

- **Obtain fetal count evaluations on or about day 55** after ovulation to help ensure fetal mineralization has progressed, making the fetuses easily identified by radiology.

  Note: *Older texts advise that fetal mineralization may be identified radiographically after day 41. However, mineralization progresses over the course of several days and there is no way to determine fertilization timing in the dog (it may happen several days after ovulation). Therefore, obtaining radiographs at day 41 is no longer a practical recommendation because a late fertilization will result in incomplete mineralization and failed radiographic detection.*

IN SUMMARY

Although it cannot be stated unequivocally that there is no risk for increased incidence in lifetime cancer rates as a result of fetal count radiographic evaluations, interpolation of the data from human medicine suggests that, given the levels of radiation used in these evaluations, the risk associated with these studies is low relative to the benefits obtained by the procedure. ■

CDC = Centers for Disease Control and Prevention; mrem = millirem

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Suggested Reading

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