Observation of the Growth Process of a Beagle Embryo and Fetus by Ultrasonography

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ABSTRACT. Detailed observation of the growth process of the embryos and fetuses (hereafter, referred to as just (fetus) of 6 pregnant Beagle bitches (14-27 months old) was carried out using ultrasonography. From daily measurements of the transversal diameter of the fetal abdomen, diameter of the fetal head and diameter of the fetal heart, significant growth curves (secondary regression equations) were obtained from the day of gestation and the measured values (p<0.01). The results of this study showed that this method can be applied to estimate the gestation age of dogs when the mating day is unknown, and determine the state of fetal growth. — KEY WORDS: canine fetus, growth curve, ultrasonography.


In recent years, ultrasonography has been widely used in the field of veterinary medicine as a method of diagnosis for all kinds of domestic animals, especially as a method of early pregnancy diagnosis in the field of theriogenology [1, 2, 5-7, 8, 9, 13, 17]. The range of applications is, however, limited when compared with human obstetrics, where the applications include estimation of fetal age [3, 14-16, 18], identification of an abnormal fetus or an abnormal pregnancy [12], as well as the determination of methods and effects of treatment [11, 19, 20]. The current range of applications of ultrasonography for dogs is limited, and there have been few detailed investigations of the fetal growth process in the dog [1, 5, 13]. In this study, therefore, we used ultrasonography to carry out a detailed observation of the embryonic and fetal growth processes in pregnant Beagle bitches for which the mating day was known, with the aim of elucidating the relationship between the embryonic and fetal growth processes and the gestation age in the dog.

In the experiments, we used 6 healthy female Beagle bitches (at time of mating, age: 14-27 months old, weight: 7.0-9.0 kg), which were bred in our laboratory. For mating, the same breed of male dogs with a good semen quality were used. The apparatus we used for ultrasonography was a linear convex electronic ultrasound scanner (Hitachi Medical Corporation, EUB-310), and the probe was a 5.0 MHz convex-type (Hitachi Medical Corporation, EBU-PC3A). For recording the images, we used a video copy processor (Mitsubishi Electric Corporation, EZU-VP2).

For uterine observation: first the dog’s abdomen was shaved and the dog was fixed in a position on its back, and then ultrasonic jelly was applied over the surface of the abdomen. The probe was placed perpendicular to the abdomen, and M-mode ultrasonic images of the intrauterine embryo or fetus were recorded while moving the probe in a direction from the uterine cervix to the uterine horn. These observations were continued daily from the day of mating until just before birth. Statistical analysis was performed by multiple regression.

Relationship between the characteristic ultrasonic image findings of embryonic and fetal growth and the age of gestation: Here, day 0 of gestation was assumed to be the final day of mating. On day 21.4 ± 1.8 (mean ± SD) of gestation (range of 18-24 days), the embryo was first recognized in the uterine cavity (fetal sac) which was dilated from fetal fluid, and a positive diagnosis of pregnancy could be made. The embryonic cardiac beat was first detected on day 23.6 ± 1.9 (21-26 days), and fetal movement was first observed on day 27.4 ± 1.3 (26-28 days). Skeletal formation, such as the cranial bone, vertebrae, costal bones and limbs, was first observed on day 29.6 ± 1.6 (27-31 days), and detailed regions such as fingers, orbits, stomach and bladder could be differentiated on day 37.0 ± 2.3 (34-39 days). An acoustic shadow accompanying ossification of the vertebrae was first observed on day 43.2 ± 2.7 (40-46 days). The number of days from the final mating day to birth (gestation period) was 61.0 ± 1.4 days (59-62 days), and the litter size was 6.0 ± 2.4 heads (3-11 heads).

Construction of the growth curve of the transversal diameter of the embryonic and fetal abdomens: The major and minor axes of the maximum cross section of the embryonic and fetal abdomens were measured, and the transversal diameter of the fetal abdomen was calculated as half the value of the sum of these two axes. Calculations were made daily for 3-5 embryos, or fetuses, in each dog from the day the embryo was first recognized (Fig. 1). From these results, the following secondary regression equation of the growth curve between the gestation age (X) and the transversal diameter of the fetal abdomen (Y) was obtained.

Fig. 1. Ultrasonographic image showing a cross section of the embryonic abdomen in a Beagle at day 30 of gestation, and a schematic drawing. The method of measuring the transversal diameter of the embryo and fetus is shown. Transversal diameter of the embryo or fetus = (major axis + minor axis)/2.
Y = 9.738 - 0.6575X + 0.02558X^2, r = 0.991, p<0.01

As can be seen in the growth curve, the transversal diameter of the fetus increased rapidly after around day 40 of gestation, which was when the embryo developed into a fetus.

Construction of the growth curve of the embryonic and fetal head diameter: As in the above, the major and minor axes of the maximum cross section of the embryonic and fetal heads were measured, and the diameter of the fetal head was calculated as half the value of the sum of these two axes (Fig. 3). From these results, the following secondary regression equation of the growth curve between the gestation age (X) and the diameter of the fetal head (Y) was obtained (Fig. 4).

Y = 23.138 + 1.098X + 0.00016X^2, r = 0.989, p<0.01

This growth curve shows that from around day 30 of gestation, which was the time when fetal head diameter measurements became possible, the head grows at an almost fixed rate.

Construction of the growth curve of the embryonic and fetal heart diameter: The major and minor axes of the maximum cross section of the heart obtained by traversing the thoracic cavity were measured, and the diameter of the fetal heart was calculated as half the value of the sum of these two axes (Fig. 5). From these results, the following secondary regression equation of the growth curve between the gestation age (X) and the diameter of the fetal heart (Y) was obtained (Fig. 6).

Y = -9.1221 + 0.2297X + 0.0057X^2, r = 0.983, p<0.01

This growth curve shows that from around day 30 of gestation, which was the time when fetal heart diameter measurements became possible, the heart grows at an almost fixed rate.

As the period of possible conception in the dog is long [10] due to the fact that dogs mating several times during one estrus, the long survival period of sperm in the oviduct, and the time it takes for the ovum to acquire fecundation capability after ovulation, it is difficult to clearly know the day of fertilization. Although the day of fertilization is usually considered as day 0 of gestation, in this study, the fetal age was calculated on the assumption that the final

![Fig. 2. Growth curve of the transversal diameter of the embryonic and fetal head during the course of gestation in the Beagle (day 0 = day of last mating).](image)

![Fig. 4. Growth curve of the diameter of the embryonic and fetal heart during the course of gestation in the Beagle (day 0 = day of last mating).](image)

![Fig. 3. Ultrasonographic image showing a cross section of the fetal head in a Beagle at day 45 of gestation, and a schematic drawing. The method of measuring the diameter of the embryonic and fetal head is shown. Diameter of the embryonic or fetal head = (major axis + minor axis)/2.](image)

![Fig. 5. Ultrasonographic image showing a vertical section of the fetal heart in a Beagle at day 50 of gestation, and a schematic drawing. The method of measuring the diameter of the embryonic and fetal heart is shown. Diameter of the embryonic or fetal heart = (major axis + minor axis)/2.](image)
that the head and heart of the fetus, unlike the abdomen, increased at an almost fixed rate until birth.

This study has shown that the growth curves we obtained of the embryo and fetus can be applied to Beagle bitches or other adult dogs of similar weight to the Beagle, in order to estimate the age of gestation and expected day of birth in cases where the mating day is not clear, as well as to make judgments concerning the state of growth of the embryo or fetus with respect to the age of gestation.

REFERENCES