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Comparison of prenatal development of Turkish Angora and Van cats

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ABSTRACT

The objectives of the present study were to gather data on the prenatal development of Turkish cats (the Angora and Van cats) and examine the effects of the breed on prenatal development. Three Angora and four Van cats, ranging in age from 3 to 4 years, were used in the present study. Depending on the stage of pregnancy, the gestational sac diameter (GSD), the fetal heart diameter (FHRTD), the fetal abdominal diameter (FAD), the fetal head diameter (FHD), the fetal gastric diameter (FGD), the fetal width of fore (FWFP) and rear footpads (FWRP) were measured by freezing the images of the fetus or fetal structure on the screen. The mean FHRTD value of the Angora cats was significantly ($P = 0.033$) greater than the corresponding value of the Van cats during the third week of gestation. The Van cats had significantly ($P = 0.008$) greater mean value of FHD than did the Angora cats during the fifth week of the gestation. There were no significant breed differences between the other fetal measurements. As a result, the prenatal development of the Angora and Van cats were found to be similar. The findings of the present study may also be used as an aid to estimate the gestational age of domestic cats.

Key words: Turkish cats, fetometry, prenatal development, ultrasonography

Introduction

The Turkish Angora and Van cats are local breeds that were developed in Turkey. The Angora cat originates from Ankara (formerly Angora) which is the capital city of Turkey (ARIKAN et al., 2003). It has colored eyes which can be any shade of blue, gold or odd-eyed (one gold eye and one blue eye) (ARIKAN et al., 2003) and is generally born deaf (DEMIRULUS, 2005). The Van cat, known as the only domestic cat breed that swims

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voluntarily, originates from Lake Van in Turkey (HELGREN, 2000). It has also blue, gold or odd-eyes (ARIKAN et al., 2003). Deaf litter birth in the Van cat is less common than the Angora cat (DEMIRULUS, 2005).

Prenatal development has been widely investigated in many animal species (ALI and FAHMY, 2008; HENDRIKS et al., 2009; KAREN et al., 2009; MORENO et al., 1996; YEAGER et al., 1992). However, there are limited number of such studies in domestic cats (ZAMBELLI et al., 2002b and 2004). The relationships were found between the gestational sac, crown-rump-length, the diameter of the fetal abdomen, the parietal diameter of the fetal skull, the diameter of the fetal stomach, the recognation of fetal organs and the gestational age in cats (ZAMBELLI et al., 2002b and 2004; ZAMBELLI and PRATI, 2006).

The diagnosis of pregnancy and determination of the gestational age are important for drug use, vaccination, nutrition, and the termination of unwanted pregnancy (EILTS, 2002; JOHNSTON et al., 2001). As in other animal species, in cats drug use and vaccination are limited during pregnancy, such as glucocorticoids, antimicrobials, antifungals, antihelminthics, anesthetics and modified live virus feline panleukopenia vaccine, because of their teratogenic effects (JOHNSTON et al., 2001; WIEBE and HOWARD, 2009). The nutritional protocol varies according to the stage of pregnancy. Queens should be fed a normal prebreeding ration (110 calories/kg per day) for the first 3 to 4 weeks of gestation. The caloric intake should be increased gradually to 165 calories/kg per day during 4 to 6 weeks of gestation and 220 calories/kg per day during the final weeks of gestation (JOHNSTON et al., 2001). Furthermore, it is nesessary to distinguish pregnancy from pseudopregnancy for the preparation of the whelping area. Ovariohysterectomy or medical treatment for the termination of unwanted pregnancy may be preferred depending on the stages of pregnancy (JOHNSTON et al., 2001).

The uterine enlargement at 4 to 14 days postcoitus and the presence of a gestational sac at 11 to 14 days postcoitus are early pregnancy ultrasonographic findings (DAVIDSON and BAKER, 2009). The detection of fetal heartbeats, fetal morphology (e. g., fetal heads, limb buds) and fetal movement are first possible at 16 to 25 days postcoitus (JOHNSTON et al., 2001). ZAMBELLI et al. (2004) achieved the determination of fetal gender at days 38-43 of gestation. The best time to estimate litter size with ultrasound is approximately at 30 days of gestation (DAVIDSON and BAKER, 2009), but the inaccuracy rate becomes higher with increasing litter size (JOHNSTON et al., 2001). The fetus is almost completely developed at day 53 of the gestation (MIGLINO et al., 2006).

Information about the prenatal development of Angora and Van cats is lacking. The objectives of the present study were to gather data on prenatal development in Angora and Van cats and examine the effects of the breed on prenatal development.

Materials and methods

Three Angora and four Van cats, ranging in age from 3 to 4 years, were used in the present study. When the signs of estrus were first observed, the female and male cats were kept together in a room with a wide angle video camera for viewing and recording the cats. After observing successful mating, the queens were seperated from the tom cat and that was recorded as the day zero of gestation.

The cats had ad libitum access to commercial dry cat food (Whiskas®, Mars, Inc., VA, USA). Fresh drinking water was also accessible at all times. The cats were exposed to natural temperature and daylight.

Physical examinations of all cats were performed before every ultrasonographic examination and no health problems were reported. The behavior of all the cats was also closely monitored and no abnormal behavior was observed during the study.

The cats were scanned daily by using an ultrasound scanner equipped with a 7.5 MHz linear transducer (HS-2000; Honda Electronics, Japan). Each cat was transabdominally scanned between 3 and 58 days' gestation. If any signs of pregnancy were not seen by day 20 of the expected pregnancy then these cats were excluded from the study.

The gestational sac diameter (GSD), the fetal heart diameter (FHRTD), the fetal abdominal diameter (FAD), the fetal head diameter (FHD), the fetal gastric diameter (FGD), the fetal width of fore (FWFP) and rear footpads (FWRP) were measured by freezing the images of the fetus or fetal structure on the screen. The FWFP and FWRP were only measured if they were visible on the screen. Otherwise no efforts were done to look for and measure them.

Each cat was weighed weekly starting from mating. At the same time, a body condition score (BCS) was given to the cats by two researchers. The Purina body condition score (LAFLAMME, 1997) was used as a subjective assessment of body condition. The BCS was given on a nine point scale, which ranged from 1 for emaciated to 9 for grossly obese. A cat with a BCS score of 5 was considered to be ideal. The BCS was the average value of the BCS given by the two researchers.

The data were first analyzed to see if they were normally distributed. The normality test revealed that the data were not normally distributed. The transformation of the data did not establish normality either. Then a non-parametric Mann-Whithney U test was used to test the difference between the two cat breeds for their traits in each week of gestation. All the traits that were measured were analyzed using SPSS 15.0 (SPSS Inc., Chicago, Illinois, USA).

Results

The mean lengths of gestation were 64 (61-66) and 62.33 (60-64) days for the Van and Angora queens, respectively. Average litter size was 4.25 (4-5) in the Van and 3.33 (3-4) in the Angora cat.

Average body weights at mating were 2.79 and 2.87 kg for the Van and Angora queens. Both cats gained approximately 1 kg during pregnancy (Table 1). The mean BCS of Angora cats were 3.41 and 4.25 at the time of mating and at the end of pregnancy, respectively. Corresponding BCS values for the Van cats were 4.18 and 4.00.

Table 1. Average body weight (BW) (kg) and BCS value in Angora and Van cats during pregnancy and mating time

Cat Breed		Mating time Mean ± SE	Pregnancy stages (week) Mean ± SE							
			1st	2nd	3rd	4th	5th	6th	7th	8th
Angora	BW	2.87 ± 0.07	2.90 ± 0.07	3.00 ± 0.01	3.08 ± 0.06	3.2 ± 0.01	3.33 ± 0.02	3.57 ± 0.06	3.74 ± 0.15	3.88 ± 0.23
	BCS	3.41 ± 0.22	3.50 ± 0.00	3.41 ± 0.22	3.41 ± 0.08	3.4 ± 0.22	3.66 ± 0.16	3.50 ± 0.28	4.00 ± 0.28	4.25 ± 0.38
Van	BW	2.79 ± 0.20	2.85 ± 0.19	2.92 ± 0.24	3.02 ± 0.27	3.0 ± 0.29	3.22 ± 0.30	3.35 ± 0.31	3.55 ± 0.33	3.73 ± 0.28
	BCS	4.18 ± 0.27	4.18 ± 0.27	4.06 ± 0.25	4.06 ± 0.32	4.1 ± 0.31	4.18 ± 0.21	4.31 ± 0.27	4.18 ± 0.18	4.00 ± 0.10

The earliest ultrasonographic sign of pregnancy was the presence of a gestational sac, which appeared as a small circular anechoic structure. The gestational sac was first detected between days 8 and 16 of gestation in the Angora cats and between days 11 and 15 of gestation in the Van cats. There were no significant mean rank differences between the two cat breeds for the GSD from week 2 to 5 (Table 2).

Table 2. Gestational sac diameter (mm) of the Angora and Van cats

Week	Cat Breed	N	Mean ± SE	Median	IQR*	Mean Rank	P value
2	Angora	10	10.30 ± 0.89	9.75	4.30	12.10	0.265
	Van	18	12.23 ±1.00	12.80	8.20	15.83	
3	Angora	24	22.55 ± 1.23	22.55	10.60	28.46	0.368
	Van	37	24.13 ± 0.78	24.10	6.50	32.65	
4	Angora	30	35.42 ± 1.08	34.80	11.00	27.60	0.141
	Van	31	38.26 ± 1.00	37.90	6.90	34.29	
5	Angora	4	43.60 ± 1.33	43.60	4.60	4.00	0.413
	Van	5	49.50 ± 3.12	49.20	13.20	5.80	

*Interquartile Range

The gestational sac started to elongate at around day 25 of gestation and became ovoid by day 30 of gestation in all pregnancies. Therefore, it was not possible to measure many gestational sacs after day 30 of gestation due to the massive enlargement of sacs. The amount of fetal fluid began to decrease at around day 45 of gestation and the fetuses were not able to move easily due to decreased fetal fluid level after day 50 of gestation.

The embryo was first detected at day 16 of gestation as an echoic structure in the gestational sac, in both breeds. Fetal movement was observed at around day 25 of gestation in all pregnancies. The fetal movement was very slight at first appearance, but it became very clear after a few days. All bones, especially the vertebras, became clearly visible after day 35 of gestation.

The fetal heart beat was detected after day 16 of gestation in both breeds. In addition, observation of the fetal heart beat in all the pregnancies started between days 16 and 19 of gestation. The earliest ultrasonographic measurement of the heart, in both breeds, was done after day 21 of gestation. The FHRTD of the Angora and Van cats are shown in Table 3. Both breeds had similar FHRTD in all weeks except week 3 in which the Angora cats had a greater mean rank of FHRTD ($P = 0.033$). The septal structure of heart was visible between days 39 and 43 of gestation in all the pregnancies except for in one Angora cat for which the septal structure was observed after day 36 of gestation. Moreover, the major vessels of the heart were distinguishable after day 48 of gestation in both breeds. The heart was progressively elongated toward the apex-basis axis after day 45 of gestation and there was also a consequent loss of the spherical shape of the heart chamber.

Table 3. Fetal heart diameter (mm) of the Angora and Van cats

Week	Cat Breed	N	Mean ± SE	Median	IQR*	Mean Rank	P value
3	Angora	3	2.63 ± 0.03	2.60	-	8.67	0.033
	Van	7	2.36 ± 0.08	2.40	0.40	4.14	
4	Angora	16	2.83 ± 0.08	2.90	0.40	22.06	0.503
	Van	24	2.75 ± 0.09	2.65	0.70	19.46	
5	Angora	20	4.47 ± 0.18	4.55	1.30	20.35	0.225
	Van	25	4.90 ± 0.19	4.80	1.70	25.12	
6	Angora	17	8.37 ± 0.30	8.20	1.60	19.85	0.944
	Van	22	8.33 ± 0.22	8.25	1.60	20.11	
7	Angora	19	12.18 ± 0.47	12.20	2.20	32.08	0.170
	Van	36	11.41 ± 0.30	11.15	2.10	25.85	
8	Angora	16	15.44 ± 0.33	15.50	2.00	25.50	0.460
	Van	30	15.22 ± 0.16	15.30	1.10	22.43	

*Interquartile Range

The FHD was first measured at day 24 and day 25 of gestation in the Van and Angora cats, respectively with increasing parietal echogenity. However, the FHD measurements in all pregnancies started between days 24 and 30 of gestation. The significant mean rank difference was observed only during week 5 (P = 0.008) in which the mean rank of the FHD was greater for the Van cats (Table 4). The brain (two seperate hemispheres) was first observed easily at day 45 of gestation.

Table 4. Fetal head diameter (mm) of the Angora and Van cats

Week	Cat Breed	N	Mean ± SE	Median	IQR*	Mean Rank	P value
4	Angora	9	7.90 ± 0.41	8.20	2.20	13.17	0.516
	Van	14	7.43 ± 0.46	7.00	3.20	11.25	
5	Angora	21	10.72 ± 0.21	10.80	1.10	17.43	0.008
	Van	24	11.89 ± 0.28	11.85	2.10	27.88	
6	Angora	20	14.52 ± 0.35	14.65	2.60	20.38	0.230
	Van	25	15.14 ± 0.32	15.20	2.50	25.10	
7	Angora	19	18.02 ± 0.34	17.70	2.60	24.21	0.597
	Van	26	17.67 ± 0.19	17.85	1.10	22.12	
8	Angora	17	20.90 ± 0.23	21.00	1.30	24.94	0.076
	Van	24	20.22 ± 0.24	20.20	2.10	18.21	

*Interquartile Range

The FAD was first measured between days 24 and 29 of gestation in all pregnancies. The FAD of the Angora and Van cats are shown in Table 5. The mean rank of the FAD of both breeds in all weeks were similar (P>0.09).

Table 5. Fetal abdominal diameter (mm) of the Angora and Van cats

Week	Cat Breed	N	Mean ± SE	Median	IQR*	Mean Rank	P value
4	Angora	9	8.88 ± 0.41	8.80	2.10	13.11	0.978
	Van	16	8.83 ± 0.39	8.90	2.00	12.94	
5	Angora	21	11.89 ± 0.38	11.90	2.80	18.36	0.097
	Van	21	12.77 ± 0.34	12.70	2.40	24.64	
6	Angora	16	18.34 ± 0.56	19.00	4.10	20.41	0.336
	Van	20	17.66 ± 0.56	17.10	4.90	16.98	
7	Angora	14	23.22 ± 0.85	23.60	5.60	21.96	0.714
	Van	27	22.66 ± 0.37	22.70	3.00	20.50	
8	Angora	13	27.25 ± 0.64	27.60	2.40	23.38	0.398
	Van	28	26.77 ± 0.47	26.75	3.80	19.89	

*Interquartile Range

The FGD was first measured between days 29 and 34 of gestation. Measurement of the FGD was first possible after days 29 and 30 of gestation in the Angora and Van cats, respectively. On those days, the FGD was measured as 2 mm in the Angora cat and 3.1 mm in the Van cat. The fetal stomach was spherical in the early stages. After that it was elongated and tortuous. The sedimentation inside the stomachs was observed after day 41 of gestation in some fetuses. No significant mean rank differences of the FGD were detected for both breeds in all weeks (P>0.1) (Table 6). The diaphragm was visible after day 41 of gestation, in both breeds.

Table 6. Fetal gastric diameter (mm) of the Angora and Van cats

Week	Cat Breed	N	Mean ± SE	Median	IQR*	Mean Rank	P value
5	Angora	14	5.95 ± 0.55	5.50	3.80	16.32	0.925
	Van	18	5.95 ± 0.45	6.50	3.30	16.64	
6	Angora	18	9.39 ± 0.69	8.80	2.80	19.86	0.590
	Van	23	9.34 ± 0.34	9.20	2.50	21.89	
7	Angora	17	13.62 ± 0.70	13.50	4.90	24.97	0.854
	Van	33	13.93 ± 0.65	13.10	6.10	25.77	
8	Angora	14	13.38 ± 0.72	13.70	4.40	14.86	0.102
	Van	22	14.84 ± 0.61	15.25	4.40	20.82	

*Interquartile Range

The FWFP was first measured at day 28 of gestation in the Angora cat (3.3 mm) and at day 31 of gestation in the Van cat (5.4 mm). The detection of rear footpads was more difficult than the fore footpads. The rear footpads were measured as 6.1, 7.1 and 5.7 mm at days 38, 40 and 41 of gestation in the Angora cat, respectively. These findings were 5.1 and 5.8 mm (at day 41), 7.2 mm (at day 46) and 8 mm (at day 48) in the Van cats. Both breeds were similar in terms of the mean rank of the FWFP in all weeks (P>0.3) (Table 7).

Table 7. Fetal width (mm) of fore footpad in the Angora and Van cats

Week	Cat Breed	N	Mean ± SE	Median	IQR*	Mean Rank	P value
5	Angora	8	6.14 ± 0.49	6.15	1.90	7.25	0.536
	Van	7	6.80 ± 0.52	7.80	2.50	8.86	
6	Angora	7	8.31 ± 0.38	8.46	0.60	9.21	0.336
	Van	8	8.18 ± 0.37	7.95	1.20	6.94	
7	Angora	3	9.37 ± 0.18	9.30	-	3.33	1.000
	Van	3	9.57 ± 0.55	9.60	-	3.67	

*Interquartile Range

Even though one fore footpad was observed at day 28 of gestation, both footpads were more easily visible after day 35 of gestation. On the other hand, measurement of footpads was very difficult after day 50 of gestation. At this stage, it was only possible to measure one fore footpad in a Van cat (10.7 mm, at day 52 of gestation).

Discussion

The average gestation time and litter size of both Turkish cats were in agreement with other domestic feline populations (ALACAM, 2007; JOHNSTON et al., 2001). The body weights of both Turkish cats reported in this study before pregnancy were similar to the weights reported by others (AGAOGLU and YUKSEK, 2005; ANONYMOUS, 1997a and 1997b; DEMIRULUS, 2005; SENLER, 1986). The BCS of Angora cats increased by almost one score from the time of mating to the end of the pregnancy, while this change of the BCS for the Van cats was not observed. The BCS of both cats reported in this study were in agreement with the BCS of the same Turkish cats reported by ERAT and ARIKAN (2010). None of the queens in this study had dystocia and this might be due to the fact that no queen cat was overweight or obese (JOHNSTON et al., 2001).

The first detection of a gestational sac in this study was after day 8 (the Angora cat) and 11 (the Van cat) of gestation. It was reported that the presence of a gestational sac can be detected at day 10 of gestation (ZAMBELLI et al., 2002b) and by day 11 to 14 of gestation (ALACAM, 2007; DAVIDSON and BAKER, 2009; KÄHN, 1994). Different ovulation times and the passing of ova into the uterus might cause different days of the first gestational sac detection. Ovulation occurs between 24 and 48 hours after coitus and the ova are fertilized in the oviduct and then pass into the uterus as morulae by days 5-6 of postcoitus in cats (ZAMBELLI and PRATI, 2006).

ZAMBELLI et al. (2002b) measured the gestational sac as 8.00, 24.94 and 35.70 mm at days 14, 22 and 30 of gestation, respectively, and this was similar to the findings of the present study in the 3rd and 4th week of gestation. KÄHN (1994) measured the gestational sac as 2-3 mm by days 11 to 14 of gestation, whereas ALACAM et al. (2005) reported the measurement of the gestational sac as 6.2 mm and 15.5 mm in the 3rd and 4th week of gestation, respectively. These results were smaller than the findings of the present study. The differences in the length of the gestational sac might be caused by breed, age, weight of feline and the number of fetuses.

The gestational sac starts to elongate and become more ovoid at around day 30 of gestation (KÄHN, 1994; ZAMBELLI and PRATI, 2006). The amount of fetal fluid decreases during the last trimester. The fetal fluid can be seen cranially and caudally to the fetuses (KÄHN, 1994). Similarly, the gestational sac also became ovoid at day 30 of gestation in the present study. On the other hand, many gestational sacs could not be measured because of their enlarged structure after day 30 of gestation. The amount of fetal fluid

decreased after day 50 of gestation. These features (ovoid shape, enlargement, decrease of fetal fluid) may support the estimation of gestational age.

The developing embryos were detectable between days 15 and 20 of gestation (ALACAM, 2007; KÄHN, 1994). The embryos were first detected around day 14 of gestation and clearly observed on day 16 of gestation by ZAMBELLI and PRATI (2006). Fetal movements were visible after day 28 of gestation. Calcification of fetal bones might occur after days 38-40 of gestation (JOHNSTON et al., 2001). Similarly, the embryo, the fetal movements and the calcification of the fetal bones were first detected at days 16, 25 and 35 of gestation, respectively in the present study.

Detection of fetal heart beat by ultrasonography was first possible between days 16 and 18 of gestation (ZAMBELLI et al., 2002a) and between days 16 and 25 of gestation (JOHNSTON et al., 2001). These findings were in agreement with this study. Although ZAMBELLI et al. (2002a) reported that the heart chamber could be detected ultrasonographically after day 50 of gestation, the heart chamber was distinguished in an early stage in this study. The mean rank differences in the FHRTD were seen only in week 3. This might be due to the fact that the fetal heart development may cause this difference. Also the detection of fetal heart beat ranged from day 16 to 19 of gestation and this might be evidence of differing fetal heart development. The major heart vessels were detected after day 50 of gestation in the study by ZAMBELLI et al. (2002a) and this agreed with the present study, which detected the major vessels of the heart after day 48 of gestation in both breeds. It can be concluded that observation of septal structure and loss of spherical shape might support the estimaton of gestational age.

Fetal morphology detection (e. g., fetal heads, limb buds) was first possible after day 26 of gestation (JOHNSTON et al., 2001). The results of the present study also demonstrated that the earliest discernible fetal head was seen on ultrasonograph after day 25 (the Angora cat) and 24 (the Van cat). The findings of the FHD in the 7^{th} and 8^{th} weeks of gestation in the Angora and Van cats were very close to the results obtained from the formula (for greater than 40 days, Gestational age = 25 x head diameter (cm) + 3) by DAVIDSON and BAKER (2009). The FHD was found as 16 mm on day 40 of gestation (ALACAM et al., 2005) and 13.5, 15.3 and 19.3 mm on days 35, 45 and 50 of gestation, respectively (ZAMBELLI et al., 2004). The results of the present study at these stages in both breeds were found to be similar. The findings of the Angora and Van cats in the 5^{th} week were significantly different ($P<0.01$). This difference can be attributable to the different prenatal developments at this stage. Furthermore, it can be concluded that the first observation of the brain at day 45 of gestation is a potentially valuable aid for the estimation of gestational age.

ZAMBELLI et al. (2004) measured the FAD as 13.2, 15.7, 18.4, 28.1 and 28.3 mm at days 30, 35, 45, 50 and 60 of gestation, respectively. Generally, the results of the present

study were smaller than these findings. The FAD might be affected by abdominal internal pressure such as swallowing the fetal fluid and meconium in large quantities. The FAD could also be used as an aid for the estimation of gestational age.

Although KÄHN (1994) reported that organogenesis in feline fetuses progressed from days 35 to 40 of gestation, the stomach was first distinguished at day 29 of gestation in the present study. ZAMBELLI et al. (2004) also reported the size of the stomach at day 30 of gestation. The FGD was measured as 2 mm in the Angora cat at day 29 and 3.1 mm in the Van cat at day 30 in the present study. This finding of the Van cats was similar to the results of ZAMBELLI et al. (2004) (3.6 mm at day 30), but the finding of the Angora cats was different. On the other hand, the other findings in both breeds were greater than findings of ZAMBELLI et al. (2004). This situation might be caused by the amount of amniotic fluid swallowed by the fetuses. The determination of tortuous and elongated stomachs, sedimentation and observation of the diaphragm could also be used as an aid for the estimation of the gestational age.

The width of the footpads could be detected at day 28 of gestation, but the footpads were more easily visible after day 35 of gestation. The reasons for this could be attributed to the discernible structure of the fetus after day 30 of gestation (KÄHN, 1994) and calcification of bones after day 38-40 of gestation (JOHNSTON et al., 2001). Similarly, ZAMBELLI et al. (2002a) reported that detection of footpads ranged from 33 to 35 day of gestation. The detection of the fore footpad was easier than the rear footpad and this could be attributed to the fore footpads being more stable beside the head. The amount of fetal fluid decreases during the last trimester (KÄHN, 1994). The determination of footpads was very difficult after day 50 of gestation as the footpads were not floating inside the uterus. There are not enough findings about the width of the fore and rear footpads in previous studies. Although it was not possible to measure the footpads for most of the time in the present study, the findings of the fore and rear footpads in the present study could be used for the determination of gestational age.

Conclusions

As a result, the findings of this study will contribute greatly to knowledge of the prenatal development of both Turkish and other domestic cat breeds. These findings can also be used as an aid to estimate the gestational age of domestic cats. The prenatal development of the Angora and Van cats were also found to be similar in this study.

References

AGAOGLU, Z. T., N. YUKSEK (2005): Van kedileri koruma altında (Van cats are under protection). Infovet 19, 70-72.

ALACAM, E. (2007): Gebelik tanısı. In: Evcil Hayvanlarda Doğum ve Infertilite. (Alacam, E., Ed.). Medisan. Ankara. pp.109-120.

ALACAM, E., H. ORAL, C. MACUN (2005): Evaluation of blood relaxin levels in bitches and queens for the diagnosis of pregnancy, false pregnancy and foetal deaths. Indian Vet. J. 82, 269-271.

ALI, A., S. FAHMY (2008): Ultrasonographic fetometry and determination of fetal sex in buffaloes *(Bubalus bubalis)*. Anim. Reprod. Sci. 106, 90-99.

ANONYMOUS (1997a): Türk Standardı (Turkish Standard), Damızlık hayvanlar-Ankara kedisi (Breeding stocks-Angora cat). Türk Standartları Enstitüsü TS:12137.

ANONYMOUS (1997b): Türk Standardı (Turkish Standard), Damızlık hayvanlar-Van kedisi (Breeding stocks-Van cat). Türk Standartları Enstitüsü TS:12138.

ARIKAN, S., S. Y. DURU, M. GURKAN, Z. T. AGAOGLU, U. GIGER (2003): Blood type A and B frequencies in Turkish Van and Angora cats in Turkey. J. Vet. Med. A. 50, 303-306.

DAVIDSON, A. P., T. W. BAKER (2009): Reproductive ultrasound of the bitch and queen. Top. Companion Anim. Med. 24, 55-63.

DEMIRULUS, H. (2005): Van kedisi. Ekoloji Magazin 8, 68-69.

EILTS, B. E. (2002): Pregnancy termination in the bitch and queen. Clin. Tech. Small Anim. Pract. 17, 116-123.

ERAT, S., S. ARIKAN (2010): Body mass index and different body measurements of Turkish Angora and Van cats in two different locations. J. Anim. Vet. Adv. 9, 118-122.

HELGREN, J. A. (2000): The Turkish Van the remarkable swimming cat. Cats October, 42-45.

HENDRIKS, W. K., B. COLENBRANDER, G. C. VAN DER WEIJDEN, T. A. E. STOUT (2009): Maternal age and parity influence ultrasonographic measurements of fetal growth in Dutch Warmblood mares. Anim. Reprod. Sci. 115, 110-123.

JOHNSTON, S. D., M. V. R. KUSTRITZ, P. N. S. OLSON (2001): Canine and Feline Theriogenology, 1st ed., W.B.Saunders, Philadelphia. pp. 414-431.

KÄHN, W. (1994): Veterinary Reproductive Ultrasonography, 1st ed., Schlütersche Verlagsanstalt und Druckerei GmbH & Co, Hannover. pp. 227-252.

KAREN, A. M., E. S. M. FATTOUH, S. S. ABU-ZEID (2009): Estimation of gestational age in Egyptian native goats by ultrasonographic fetometry. Anim. Reprod. Sci. 114, 167-174.

LAFLAMME, D. (1997): Development and validation of a body condition score system for cats: A clinical tool. Feline Pract. 25, 13-18.

MIGLINO, M. A., C. E. AMBROSIO, D. S. MARTINS, C. V. WENCESLAU, C. PFARRER, R. LEISER (2006): The carnivore pregnancy: The development of the embryo and fetal membranes. Theriogenology 66, 1699-1702.

MORENO, C., C. C. STEINMANN, K. BICKHARDT (1996): Fetal heart rate measurement and sonographic fetometry for determination of fetal age in sheep. Dtsch. Tierärztl. Wochenschr. 103, 478-480.

SENLER, N. G. (1986): Van kedisinin biyoloji ve davranış özellikleri (Biology and behavioral characteristics of Van cat). Dissertation. Yüzüncü Yıl University of Sciences Institute. Van, Turkey.

WIEBE, V. J., J. P. HOWARD (2009): Pharmacologic advances in canine and feline reproduction. Top. Companion Anim. Med. 24, 71-99.

YEAGER, A. E., H. O. MOHAMMED, V. MEYERS-WALLEN, L. VANNERSON, P. W. CONCANNON (1992): Ultrasonographic appearance of the uterus, placenta, fetus, and fetal membranes throughout accurately timed pregnancy in Beagles. Am. J. Vet. Res. 53, 342-351.

ZAMBELLI, D., B. CANEPPELE, S. BASSI, C. PALADINI (2002a): Ultrasound aspect of fetal and extrafetal structures in pregnant cats. J. Feline Med. Surg. 4, 95-106.

ZAMBELLI, D., C. CASTAGNETTI, S. BELLUZZI, S. BASSI (2002b): Correlation between the age of the conceptus and various ultrasonographic measurements during the first 30 days of pregnancy in domestic cats *(Felis catus)*. Theriogenology 57, 1981-1987.

ZAMBELLI, D., C. CASTAGNETTI, S. BELLUZZI, C. PALADINI (2004): Correlation between fetal age and ultrasonographic measurements during the second half of pregnancy in domestic cats *(Felis catus)*. Theriogenology 62, 1430-1437.

ZAMBELLI, D., F. PRATI (2006): Ultrasonography for pregnancy diagnosis and evaluation in queens. Theriogenology 66, 135-144.

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SAŽETAK

Cilj ovog istraživanja bio je prikupiti podatke o prenatalnom razvoju turskih mačaka pasmine Angora i Van i istražiti učinke uzgoja na njihov prenatalni razvoj. U istraživanje su uzete tri angorske i četiri vanske (Van je jezero u Turskoj) mačke u dobi od tri do četiri godine. Ovisno o stupnju bređosti, na zaustavljenoj slici na ekranu izmjeren je promjer gestacijske vreće, fetalnoga srca, fetalnoga trbuha, fetalne glave, fetalnoga želuca te širina prednjih i stražnjih šapica. Srednja vrijednost veličine fetalnoga srca angorskih mačaka bila je značajno ($P = 0,033$) veća od one u vanskih mačaka tijekom trećeg tjedna gestacije. Vanske mačke imale su značajno veću ($P = 0,008$) srednju vrijednost fetalne glave od angorskih mačaka tijekom petoga tjedna gestacije. Nisu ustanovljene značajne pasminske razlike između drugih mjerenih pokazatelja. Ustanovljeno je da je prenatalni razvoj u angorskih i vanskih mačaka međusobno sličan. Nalazi ovog istraživanja mogu se rabiti kao pomoć u procjeni fetalne dobi u domaćih mačaka.

Ključne riječi: turske mačke, fetometrija, prenatalni razvoj, ultrasonografija