Pregnancy rates according to follicle diameter and uterus edema in different age groups in two consecutive ovulations in Arabian mares

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ABSTRACT

The study aimed to evaluate the pregnancy rates of mares in different age groups based on follicle diameter and uterine edema during two consecutive ovulations in three breeding seasons. Thirty Arabian mares were divided into two groups: below and equal to 10 years (Group A=54) and above 10 years old (Group B=36). Throughout the breeding season, the diameters of ovulatory follicles and uterine edema were recorded. After the first ovulation, when the follicle diameters of all mares in both Group A and Group B were analyzed independently of age, and compared between pregnant and non-pregnant mares, no differences were found (P>0.05). The differences between the age-related groups were insignificant (P>0.05). Follicle diameters between pregnant and non-pregnant mares at the second ovulation were significantly different (P<0.05). It was determined that there was no relationship between age and pregnancy rate (P>0.05). Differences between uterine edema values determined in mares that were pregnant and non-pregnant in two consecutive ovulations were found to be insignificant in terms of pregnancy (P>0.05). As a result, although preovulatory diameter is not a reliable marker for pregnancy detection, it remains an important parameter for determining ovulation and artificial insemination timing. Uterine edema is only useful for determining the timing of insemination and is not associated with pregnancy. Moreover, since similar pregnancy rates were observed among different age groups, age alone is not a sufficient parameter for assessing reproductive efficiency in mares.

Key words: follicle diameter; ovulation; mare; uterine edema

Introduction

Mares are seasonal breeders with ovulatory activity being related to longer days (seasonal polyestric animals). Ovulatory periods occur between March to October in the Northern Hemisphere. However, the breeding season officially begins on February 15 and lasts until the end of June for racing breeds. The incidence of ovulation transitionally decreases before and after the natural reproductive season (BERGFELT, 2009; LOVE, 2009; AURICH, 2011). The full

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estrous cycle is about 21 days, with 5 to 7 days of estrus (CROWELL-DAVIS, 2007). In mares, some changes occur in terms of follicular activity before the breeding season begins. During the anoestrus period, small follicular developments are seen with a diameter of less than 21 mm, while follicles in the transitional period can reach preovulatory sizes, although they often do not result in ovulation (AURICH, 2011). Ovulation occurs 24-48 hours before the end of the estrus period in mares during the breeding season. During the breeding season, 1 or 2 follicular waves are seen in each cycle, and the ovulatory follicle is usually formed in the first wave (DONADEU and PEDERSEN, 2008). In mares, follicles with a diameter of 6-13 mm must be formed before the follicular wave can begin. The follicle, which reaches 22 mm in diameter during the follicular wave, continues to develop as the dominant follicle, while the secondary follicles regress. The dominant follicle, when it reaches an average diameter of 35-45 mm, and the blood luteinizing hormone (LH) level reaches a sufficient level, can either ovulate or regress. In addition, a second wave in which preovulatory follicles develop can be seen in the luteal phase (AURICH, 2011). The lower limit of the follicle diameter required for ovulation to occur in mares is accepted as 35-40 mm. Despite this, in many mares, ovulation has been observed to occur when the follicle diameter is below 35 mm, but in some mares, it has been detected that the diameter of the ovulatory follicle is more than 50 mm (CUERVO-ARANGO and NEWCOMBE, 2008). Various ultrasonographic findings, such as the size of the follicle, changes in follicular shape from spherical to pear-shaped, echogenicity of the follicular fluid, and the thickness of the follicular wall, can be used to predict the time of ovulation. Among these, the finding that can be measured most practically is the follicle diameter (GASTAL et al., 1998). However, since the diameter required for a follicle to be an ovulatory follicle is in a wide range, and follicle development is observed in the luteal phase, it is understood that only examining the diameter of the follicle by an ultrasonographic examination is insufficient to determine the time of ovulation (CUERVO-ARANGO and NEWCOMBE, 2008;

SAMPER, 2010). Therefore, it is important to check the physiological state of the uterus as well as the ovary in mares during the mating season. Due to the high amount of estrogen, especially in the preovulatory period, the level of uterine edema increases (SAMPER, 2010). When the amount of estrogen in the blood reaches the maximum level, the amount of endometrial edema also reaches the maximum level, despite the fact that the amount of edema in the uterus regresses during ovulation to levels that cannot be measured (SAMPER, 1997). Uterine edema can be graded on a scoring scale between 0-5 (SAMPER, 2010). These scoring scales, along with the level of uterine edema that varies according to the phase of cyclic activity in mares, are used as an auxiliary indicator to determine ovulation and the most suitable timing for insemination, considering hormonal balance and follicular dynamics. In order to provide controlled and successful reproductive efficiency, it is necessary to know the physiology of the estrous cycle and to determine the ovulation time correctly (SAMPER, 2010).

Reproductive efficiency can be affected by several factors. Among these factors, aging of mares is one of the important phenomena for the emergence of infertility problems. The incidence of problems such as: endometritis, anovulatory follicles, ovarian dysfunction, uterus luminal cysts, salphingitis, early embryonic deaths, morphological abnormalities of the embryo, etc., increases as mares age (MCCUE and SQUIRES, 2002; ALLEN et al., 2006; FIALA et al., 2006; PYCOCK, 2009).

In the present study the follicle diameters at the time of insemination and the uterine edema scores were examined during two consecutive ovulations in three breeding seasons of Arabian horse mares. In addition, the analyzed data were compared with the data from the 14th day of pregnancy in groups with animals younger and older than 10 years of age. This clinical evaluation aimed to demonstrate the determining power of the relationship between the successive estrous cycles, the age scale, and pregnancies of Arabian horse mares during the breeding season concerning mare fertility.

Materials and methods

Ethical Statement. Ethics committee approval was not required for this study as it is within the scope of veterinary practice. The study involved only routine examinations and data collection. The authors confirm that they adhered to ARRIVE Guidelines to protect animals used for scientific purposes.

Experimental design. In the study, 30 Arabian horse mares located in private enterprises (Mahmudiye/Eskişehir) aged between 5 and 18 years were followed for two consecutive ovulations in three breeding seasons, and the data obtained were evaluated. The mares were checked in terms of their gynecological and general health condition, and it was determined that they were healthy before the examinations were made. The mares were housed in individual paddocks, and fed commercial concentrate, alfalfa hay, and ad libitum water. The first and second ovulations of the mares used in the study were followed during three breeding (estrus) seasons. The mares (3x30) (n=90) were divided into 2 groups: under 10 years old (Group A; n=54) and 10 years old (Group B; n=36) and above. All mares were evaluated and recorded for ovulatory follicle diameters and uterine edema using B-mode (5 mHz probe) transrectal ultrasonography (Sonosite II, Fujifilm, Japan) on the day of artificial insemination for each mare in the breeding season. All inseminations were performed with fresh semen between March (1st) and May (31st). As the next step, a pregnancy examination was performed on the 14th day after the first artificial insemination. Those who were not pregnant (n=43) were examined using the same method at their second ovulation (Group A=24; Group B=19). An ultrasound probe was placed transrectally on the ovary to detect follicle diameters, and the presence of anechoic follicles was detected. The image was frozen so that the entire follicle was on the screen. Then the diameters of the ovulatory follicles were determined by measuring their width and height with the help of ultrasound. To detect uterine edema, the ultrasound probe was placed transrectally on the cornu of the uterus on the ovulating side. A cross-sectional image was taken from the closest region of the cornu to the corpus uteri, and it was scored subjectively by giving a value between 0

and 5 according to (SAMPER, 2010). Scores were determined in increments of 1 on the basis of the size and prominence of the endometrial folds. On the 14th day after insemination, the ultrasound probe was brought over the uterus transrectally, and the presence of an embryo was searched for in the pregnancy examination. The mares in which embryos were detected were classified as 'pregnant', while the ones in which embryos were not detected were classified as 'non-pregnant'.

Statistical analysis. Before statistical analysis, data were analyzed as parametric test assumptions for normality with the Kolmogorov-Smirnov test and homogeneity of variances with the Levene test. Descriptive statistics were calculated for each variable and presented as ''Mean ± Standard Error of the Mean''. Two-factor analysis of variance was used to test the effects of age groups (<10 year old and ≥10 year old), pregnancy status (not pregnant and pregnant) and their interaction for each parameter. Pairwise comparisons were done using the Bonferroni adjustment. Pregnancy rates between the groups were evaluated by chi-square analysis. A statistically significant level was determined as $P<0.05$. The analyses of the data obtained in the study were evaluated using the SPSS 23 (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk NY: IBM Corp.) statistical package program.

Results

In the light of the data obtained as a result of two consecutive ovulations in mares during three breeding seasons, the pre-ovulatory follicle diameters during the first ovulations of the mares in Group A were measured as 45.83±0.78 mm for the pregnant ones and 46.95±0.83 mm for the non-pregnant ones ($P>0.05$) (Table 1). Follicle diameters were determined as 45.86±0.82 mm and 44.70±0.80 mm in pregnant and non-pregnant mares in Group B (Table 1), respectively ($P>0.05$). Therefore, the follicle diameters of all the mares (n=90) were analyzed regardless of age (Fig. 1), and the differences between pregnant (45.85%) and non-pregnant mares (45.82%) were concluded to be statistically insignificant ($P>0.05$). Similarly, in

the second ovulations, the follicle diameter of the mares in Group A was 46.00±1.09 mm in pregnant mares and 44.00±1.88 mm in non-pregnant mares. The follicle diameters of pregnant and non-pregnant mares in Group B were 47.44±1.00 mm and 43.20±1.88 mm, respectively. The differences between age-related groups (Table 1) were not found to be statistically significant (P>0.05). Moreover, the age-independent pregnancy rates of second ovulations were evaluated, and the follicle diameters were determined to be 46.72 mm in pregnant mares and 43.60 mm in non-pregnant mares (Fig. 1). The differences between follicle diameter values between pregnant and non-pregnant mares at the second ovulations were statistically significant (P<0.05). Likewise, when the mean uterine edema score at the first ovulation (Table 1), was evaluated, it was calculated as 3.47±0.17 and 3.34±0.17 for pregnant and non-pregnant mares in Group A (P>0.05), and 3.22±0.17 and 3.34±0.17 for pregnant and non-pregnant mares in Group B (P>0.05). Uterus edema scores were determined for all pregnant and non-pregnant mares (age-independent; n=90) at the first ovulations to be 3.34 and 3.33 (P>0.05), respectively (Fig. 1). The edema scores of the cornu uteri were calculated for the pregnant and non-pregnant mares at the second

ovulations as 2.80±0.20 and 3.01±0.34 for Group A (P>0.05), and 2.79±0.18 and 2.80±0.34 for Group B (P>0.05), respectively (Table 1). Furthermore, age-independent edema scores in the cornu uteri of all mares (n=90) at the second ovulation (Fig. 1) were determined to be 2.79 for pregnant mares and 2.90 for non-pregnant mares (P>0.05). Finally, at the second ovulations, the differences in the means of the edema scores between both age-related and age-independent groups were not concluded to be statistically significant (Table 1 and Fig. 1).

Over the course of three seasons, after the first ovulations, pregnancy was observed in 29 out of 54 mares (53.7%) from Group A and in 17 out of 36 mares (47.2%) from Group B (p=0.667). Overall pregnancies were detected in 46 (51.1%) of all mares (n=90) at the first ovulations. No statistical difference was observed between the groups in terms of pregnancy rates at the first ovulations (Table 2). When the second ovulations were examined, pregnancies were observed in 18 (75%) of 24 mares from Group A and 15 (78.9%) of 19 mares from Group B (P=0.994). Overall, pregnancies were detected in 33 (76.7%) out of 43 mares at the second ovulations. No significant difference was observed between Groups A and B in terms of pregnancy rates at the second ovulations (Table 3).

Table 1. Pregnancy status between the groups in terms of follicle diameter and uterine edema scores at first and second ovulations in three breeding seasons (Mean ± Standard deviation)

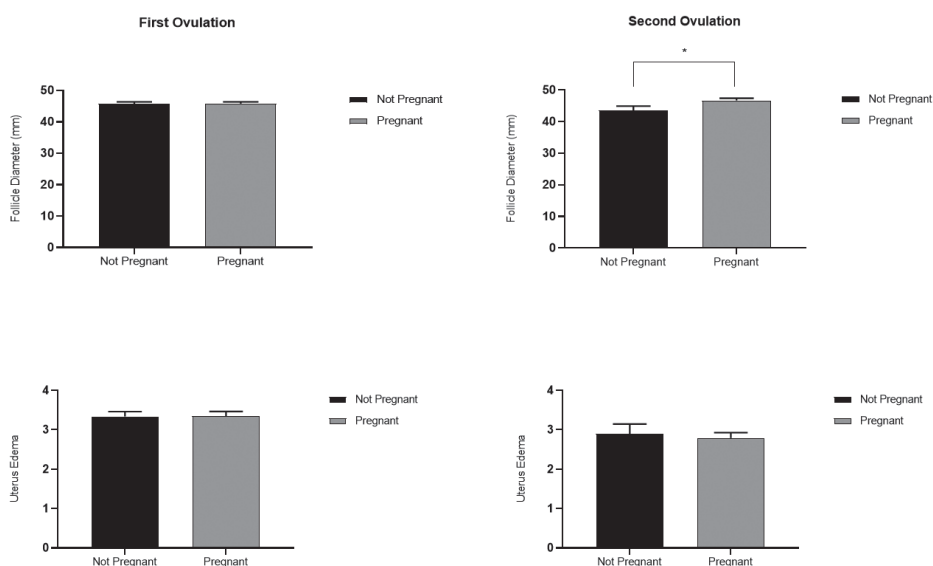| | | Groups | Pregnancy status | | P | | |
			Not pregnant	Pregnant	Age	Pregnancy	A*P
First ovulation	Follicle diameter (mm)	Group A	46.95 ± 0.83	45.83 ± 0.78	ns	ns	ns
		Group B	44.70 ± 0.80	45.86 ± 0.82			
	Uterus edema (1-5)	Group A	3.34 ± 0,17	3.47 ± 0,17	ns	ns	ns
		Group B	3.34 ± 0.17	3.22 ± 0.17			
Second ovulation	Follicle diameter (mm)	Group A	44.00 ± 1.88	46.00 ± 1,09	ns	*	ns
		Group B	43.20 ± 1.88	47.44 ± 0.99			
	Uterus edema (1-5)	Group A	3.01 ± 0.34	2.80 ± 0.20	ns	ns	ns
		Group B	2.80 ± 0.34	2.79 ± 0.18			

ns: not significant; *: P<0.05

Fig. 1. Pregnancy status in terms of follicle diameter and uterus edema scores at the first and second ovulations of all mares (n=90) regardless of age in three breeding seasons

*: P<0.05

Table 2. Pregnancy rates between groups at 1st ovulations in three breeding seasons

Groups		Pregnancy status	
		Not pregnant	Pregnant
Group A (<10 age)	N	25	29
	%	46.3%	53.7%
Group B (≥10 age)	N	19	17
	%	52.8%	47.2%
Chi-Square = 0.363; P = 0.667			

Table 3. Pregnancy rates between groups at 2nd ovulations in three breeding seasons

Groups		Pregnancy status	
		Not pregnant	Pregnant
Group A (<10 age)	N	6	18
	%	25.0%	75.0%
Group B (≥10 age)	N	4	15
	%	21.1%	78.9%
Chi-Square = 0.093; P = 0.994			

Discussion

There is limited information on the reproductive efficiency of mares of different breeds. In a comprehensive study (WARRIACH et al., 2014), the conception rates of Arabian mares at first ovulation were indicated as 75% and in Thoroughbred mares 62%. Therefore, the pregnancy rates following the second ovulations were reflected as 45% and 22% in Arabian and Thoroughbred mares, respectively. In contrast, lower pregnancy rates (53.7% in Group A; 47.2% in Group B) were obtained in the first ovulations, while higher pregnancy rates (75.0% in Group A; 78.9% in Group B) were obtained in the second ovulations in the present study. In other studies, similar pregnancy rates were detected in the first cycles in Thoroughbred and Standardbred mares (NATH et al., 2010) and Konik Polski and Thoroughbred mares (GORECKA et al., 2005). On the other hand, in an impressive review conducted by KATILA et al. (2010), it was demonstrated that there are various levels of reproductive efficiency in different breeds, however, there are doubtful results indicating the direct effects of breed features on fertility. Besides the breed of the animals, there are many extrinsic factors influencing the reproductive performance of mares, such as the size of the stallion's book, the stallions' age, mating management, and environmental conditions (KATILA et al., 2010). In such studies it has been indicated that pregnancy rates in hand mating were found to be lower than in free mating or artificial insemination (LANGLOIS and BLOUIN, 2004). In another study, artificial insemination performed with fresh semen had higher pregnancy rates than using cooled or frozen semen (SAIRANEN et al., 2008). The most effective months for breeding in mares were determined to be the March to May period of the breeding season (KRUSZYNSKI et al., 2011). The present study was conducted with the same, most efficient conditions for all mares, to provide uniformity throughout the study. In this regard, inseminations with fresh semen were performed between March and May. In addition, a single breed of mares (Arabian) was used to avoid conflicting results because some aspects of the breed effect on fertility efficiency are unknown.

Reproductive examinations have great importance to ensure healthy reproduction in mares. The reproductive physiologies of mares in different age groups in particular can vary (AURICH, 2011). Aging is one of the most common factors known to cause infertility problems. The incidence of poor reproductive performance increases as mares age. (MCKINNON et al., 2011). As they age, ovarian activity and follicular development begin to decrease, and the inter-ovulatory intervals increase. The reason for this is mainly attributed to the slowing of follicular development during the first wave of the estrous cycle (DONADEU and PEDERSEN, 2008). In a study conducted on 419 mares aged 4-23, it was revealed that there was a significant difference between the pregnancy rates of young, middle-aged, and older animals (P<0.05) (BALL et al., 2019). In another study conducted on 220 mares, it was revealed that the age of the mares that became pregnant was younger than that of the non-pregnant mares (P=0.015) (SCARLET et al., 2023). In another study examining 768 mares between the ages of 3 and 22, it was found that pregnancy rates varied significantly depending on age (P=0.017) (MATEU-SANCHEZ et al., 2016). Contrary to these studies, in the present study, 90 mares aged 5-18 years were examined, and it was determined that age was not associated with pregnancy rate (P>0.05). It is thought that the differences between the studies may be due to the high age ranges of the animal material used. In addition, TRAVERSARI et al. (2019) from a study of 127 middle-aged (9-18 years) and young (3-8 years) mares, it was observed that age had no effect on the pregnancy rate, similar to the present study (P>0.05) (TRAVERSARI et al., 2019). It may be that the differences in the results obtained from the studies mentioned above may have been due to the higher numbers of mares used (BALL et al., 2019; MATEU-SANCHEZ et al., 2016). In addition, in the light of the data obtained from these studies, it can be deduced that it may be appropriate to re-evaluate the age categorization of old and young mares.

During estrus in mares, follicles grow by an average of 3 mm per day. This growth continues

until the diameter of the preovulatory follicles is 35-45 mm on average. Moreover, it is also known that the preovulatory follicle diameters of mares can show individuality and be larger or smaller than the average. It has been said that this situation should be taken into consideration in order to achieve a successful pregnancy (DONADEU and PEDERSEN, 2008). In addition, it has been suggested that the larger the diameter of the follicle that ovulates, the higher the quality of the ovulation (CUERVO-ARANGO and CLARK, 2010). The reason for this is the belief that a larger ovulated follicle will form a larger corpus luteum (CUERVO-ARANGO and NEWCOMBE, 2013; SPENCER et al., 2022). Thus, it is thought that the higher level of progesterone secreted from the corpus luteum will create a suitable uterine environment for embryonic development and the continuation of pregnancy. In addition, it is believed that in this way embryonic losses that may occur in the early stages of pregnancy can be minimized (ALLEN, 2001; SPENCER et al., 2022). In a study conducted by CANISSO et al. (2013) the control group (K) without hormones and the groups using altrenogest (A) and controlled internal drug release (CIDR) (C) were inseminated every 48 hours after a follicle with a diameter of 35 mm was formed in the ovary (CANISSO et al., 2013). In the study, pregnancy rates in the groups were: K - 61%, A- 36%, C- 47%, and the preovulatory follicle diameters were K: 40.96±0.68 mm, A: 40.71±0.85 mm and C: 40.82±0.88 mm. Although there are numerical differences between the K group and the other groups in terms of pregnancy rates, no statistical difference was determined (P=0.09). In addition, it was observed that follicle diameters were similar in all three groups, and there was no statistical difference (P=0.86). In another similar study, preovulatory follicle diameters in spontaneous ovulations in two consecutive estrus cycles were measured, and no difference was observed in terms of follicle diameters between these two ovulations (P>0.05) (CUERVO-ARANGO and NEWCOMBE, 2008). Another study found that age was not statistically significant for preovulatory follicle diameter in mares aged 3-17 years (P=0.219) (GONCALVES et al., 2020). Findings from another study in mares

showed no correlation between maternal age and oocyte developmental competence (the ability of oocytes to mature, fertilize, divide, and develop into a transferable blastocyst) or embryo quality (CUERVO-ARANGO et al., 2019). In a different study, ovulation was induced by human chorionic gonadotropin (hCG) in groups with follicles >35mm and endometrial edema scores between moderate and severe. In the study, in which the pregnancy rate was 65.2%, no difference was observed between the animals that became pregnant at the first ovulation and those that did not in terms of follicle diameter. In the present study, the mean follicle diameter of the animals that became pregnant at the second ovulation was 46.722±0.736 mm, and in the animals that did not conceive it was 43.600±1.332 mm (P<0.05). As a result of this study, it was observed that the follicle diameters measured at the first ovulation did not have any determinative effect on pregnancy, similar to other studies. However, it was concluded that different follicle diameters were effective in determining pregnancy status between pregnant and non-pregnant mares in the subsequent second ovulations. This situation leads to the conclusion that mares that do not become pregnant in the first ovulations should be examined in more detail in terms of preovulatory follicle diameters in subsequent ovulations. On the other hand, it is thought that the induction of ovulation observed in studies may affect the results. To the best of our knowledge, measuring the follicle diameters for predicting pregnancy in two consecutive ovulations was conducted for the first time, and it was determined that the second ovulation was more predictive of pregnancy than the first one.

ATAYDE and ROCHA (2010) stated that in 77% of mares, uterine edema can be seen up to 32.4±25.6 days before the first ovulation (ATAYDE and ROCHA, 2010). In another study, it was stated that endometrial edema may increase in the follicular cycle between luteolysis and ovulation (P<0.05), but 36.4% of mares conceived, although no uterine edema was observed (MATEU-SANCHEZ et al., 2016). In a different study, the relationship was investigated between estrous endometrial edema and progesterone production

two weeks after ovulation in pregnant mares. As a result, it was stated that the absence of an increase in endometrial edema 14 days after ovulation can be explained by the fact that the progesterone concentration is always above 1 ng/ml (GRABOWSKA and KOZDROWSKI, 2022). CUERVO-ARANGO and NEWCOMBE (2008) found no significant increase in uterine edema in mares with spontaneous ovulation (CUERVO-ARANGO and NEWCOMBE, 2008). In addition to their work, which is consistent with the results obtained in this study, SAMPER (1997) determined that uterine edema can be evaluated as a criterion for determining the time of ovulation. Accordingly, it has been reported that uterine edema increases with estrus, and begins to decrease just before ovulation. While the mean uterine edema score was 1.3, the follicle size was >35mm in 414 of 452 mares. WATSON et al. (2003) determined the rate of uterine edema at first and second ovulations to be 86% and 100%, respectively. In this study, the higher rate of edema in the second preovulatory period than in the first preovulatory period was seen as a statistically significant difference. In the present study, the differences between uterine edema values determined in pregnant and non-pregnant mares at two consecutive ovulations were found to be insignificant in terms of pregnancy. In conclusion, it was concluded that uterine edema is not associated with pregnancy, but can only be used to determine the appropriate insemination time.

Conclusions

As a result, although the diameter of the preovulatory follicle is not a strong predictor for pregnancy detection, it was found that it is an important parameter to determine the time of ovulation and artificial insemination. Moreover, it was found that it is difficult to establish a strong correlation between uterine edema, ovulation, and pregnancy, but these data are decisive parameters in the evaluation of uterine health. Additionally, the pregnancy rates observed between different age groups were found to be similar. Thus, it was concluded that age alone should not be used as a criterion for estimating the reproductive efficiency of mares.

References

ALLEN, W. R (2001): Luteal deficiency and embryo mortality in the mare. Reprod. Domest. Anim. 36, 121-131.
https://doi.org/10.1046/j.1439-0531.2001.00312.x

ALLEN, W. R., S. WILSHER, L. MORRIS, J. S. CROWHURST, M. H. HILLYER, H. N. NEAL (2006): Re-establishment of oviducal patency and fertility in infertile mares. Anim. Reprod. Sci. 94, 242-243.
https://doi.org/10.1016/j.anireprosci.2006.04.035

ATAYDE, L., A. ROCHA (2010): Selected ovarian ultrasonographic characteristics during vernal transition are useful to estimate time of first ovulation of the year. Reprod. Dom. Anim. 46, 240-246.
https://doi.org/10.1111/j.1439-0531.2010.01650.x

AURICH, C. (2011): Reproductive cycles of horses. Anim. Reprod. Sci. 124, 220-228.
https://doi.org/10.1016/j.anireprosci.2011.02.005

BALL, B. A., H. E. ALI, K. E. SCOGGIN, W. T. RIDDLE, M. SCHNOBRICH, E. BRADEKAMP, M. AGNEW, E. L. SQUIRES, M. H. T. TROEDSSON (2019): Relationship between anti-Müllerian hormone and fertility in the mare.

Theriogenology 125, 335-341.

https://doi.org/10.1016/j.theriogenology.2018.11.005

BERGFELT, D. R. (2009): Anatomy and Physiology of the Mare. In: Equine breeding management and artificial insemination. (Samper, J. C., Ed.), 2nd ed., Saunders Elsevier, St. Louis, pp. 113-131.

CANISSO, I. F., K. GALLACHER, M. A. GILBERT, A. KORN, C. M. SCHWEIZER, S. J. BEDFORD-GUAUS, R. O. GILBERT (2013): Preovulatory progestagen treatment in mares fails to delay ovulation. Vet. J. 197, 324-328.

https://doi.org/10.1016/j.tvjl.2012.12.028

CROWELL-DAVIS, S. L. (2007): Sexual behavior of mares. Horm. Behav. 52, 12-17.

https://doi.org/10.1016/j.yhbeh.2007.03.020

CUERVO-ARANGO, J., A. N. CLAES, T. A. STOUT (2019): A retrospective comparison of the efficiency of different assisted reproductive techniques in the horse, emphasizing the impact of maternal age. Theriogenology 132, 36-44.

https://doi.org/10.1016/j.theriogenology.2019.04.010

CUERVO-ARANGO, J., J. R. NEWCOMBE (2013): Ultrasound confirmation of ovulation in mares: a normal corpus luteum or a haemorrhagic anovulatory follicle?. Reprod. Domest. Anim. 48, 105-111.

https://doi.org/10.1111/j.1439-0531.2012.02039.x

CUERVO-ARANGO, J., A. CLARK (2010): The first ovulation of the breeding season in the mare: The effect of progesterone priming on pregnancy rate and breeding management (hCG response rate and number of services per cycle and mare). Anim. Reprod. Sci. 118, 265-269.

https://doi.org/10.1016/j.anireprosci.2009.08.008

CUERVO-ARANGO, J., J. R. NEWCOMBE (2008): Repeatability of preovulatory follicular diameter and uterine edema pattern in two consecutive cycles in the mare and how they are influenced by ovulation inductors. Theriogenology 69, 681-687.

https://doi.org/10.1016/j.theriogenology.2007.11.019

DONADEU, F., H. PEDERSEN (2008): Follicle Development in Mares. Reprod. Domest. Anim. 43, S224-S231.

https://doi.org/10.1111/j.1439-0531.2008.01166.x

FIALA, S. M., M. G. AMARAL, C. A. PIMENTEL, P. D. ROSA, G. G. COSTA, G. D. OLİVEİRA, R. CERETTA, R. C. MATTOS (2006): Inflammatory lesions in the mare's oviducts. Anim. Reprod. Sci. 94, 265-267.

https://doi.org/10.1016/j.anireprosci.2006.03.025

GASTAL, E. L., M. O. GASTAL, O. J. GINTHER (1998): The suitability of echotexture characteristics of the follicular wall for identifying the optimal breeding day in mares. Theriogenology 50, 1025-1038.

https://doi.org/10.1016/s0093-691x(98)00205-2

GONCALVES, G. R., F. MOROTTI, A. H. B. COLOMBO, D. V. BONATO, C. BIZARRO-SILVA, C. O. ROSA, F. L. B. CAVALIERI, M. M. SENEDA (2020): Influence of age and ovarian antral follicle count on the reproductive characteristics of embryo donor mares. Vet. Rec. 186, 564.

https://doi.org/10.1136/vr.105526

GORECKA, A., T. A. JEZIERSKI, K. SLONIEWSKI (2005): Relationship between sexual behaviour, dominant follicle area, uterus ultrasonic image and pregnancy rate in mares of two breeds differing in reproductive efficiency. Anim. Reprod. Sci. 87, 283-293.

https://doi.org/10.1016/j.anireprosci.2004.11.007

GRABOWSKA, A., R. KOZDROWSKI (2022): Relationship between estrus endometrial edema and progesterone production in pregnant mares two weeks after ovulation. BMC Vet. Res. 18, 414.

https://doi.org/10.1186/s12917-022-03512-0

KATILA, T., K. NIVOLA, T. REILAS, J. SAIRANEN, T. PELTONEN, A. M. VIRTALA (2010): Factors affecting reproductive performance of horses. Pferdeheilkunde 26, 6-9.

KRUSZYNSKI, W., M. MALISZEWSKA, K. WILK (2011): The analysis of mare ovaries activity depending on month of reproductive season, breed and age. Biologia i Hodowla Zwierzat 63, 169-174.

LANGLOIS, B., C. BLOUIN (2004): Statistical analysis of some factors affecting the number of horse births in France. Reprod. Nutr. Dev. 44, 583-595.

https://doi.org/10.1051/rnd:2004055

LOVE, C. C. (2009): Evaluation of Reproductive Efficiency. In: Equine breeding management and artificial insemination. (Samper, J. C., Ed.), 2nd ed., Saunders Elsevier, St. Louis, pp. 289-294.

MATEU-SANCHEZ, S., J. R. NEWCOMBE, C. GARCES NARRO, J. CUERVO-ARANGO (2016): The period of the follicular phase during which the uterus of mares shows estrus-like echotexture influences the subsequent pregnancy rate. Theriogenology 86, 1506-1515.

https://doi.org/10.1016/j.theriogenology.2016.05.009

MCCUE, P. M., E. L. SQUIRES (2002): Persistent anovulatory follicles in the mare. Theriogenology 58, 541-543.

https://doi.org/10.1016/S0093-691X(02)00769-0

MCKINNON, A. O., E. L. SQUIRES, W. E. VAALA, D. D. VARNER (2011): Equine Reproduction. 2nd ed., John Wiley & Sons, West Sussex, pp: 1-3331.

NATH, L. C., G. A. ANDERSON, A. O. MCKINNON (2010): Reproductive efficiency of Thoroughbred and Standardbred horses in North-east Victoria. Aust. Vet. J. 88, 169-175.

https://doi.org/10.1111/j.1751-0813.2010.00565.x

PYCOCK, J. F. (2009): Breeding Management of the Problem Mare. In: Equine breeding management and artificial insemination. (Samper, J. C., Ed.), 2nd ed., Saunders Elsevier, St. Louis, pp. 150-164.

SAIRANEN, J., K. NIVOLA, T. REILAS, T. KATILA (2008): Factors affecting reproductive performance of Finnish

trotter stallions. Anim. Reprod. Sci. 107, 345-346.

https://doi.org/10.1016/j.anireprosci.2008.05.123

SAMPER J. C (2010): A review of a practitioner's perspective on endometrial edema. Pferdeheilkunde 26, 14-18.

https://doi.org/10.21836/PEM20100103

SAMPER, J. C. (1997): Ultrasonographic appearance and the pattern of uterine edema to time ovulation in mares. Proceedings of the 43rd Annual Convention of the American Association of Equine Practitioners, 7-10 December, Phoenix, Arizona, pp. 189-191.

SCARLET D., E. MALAMA, S. FISCHER, B. KNUTTI, H. BOLLWEIN (2023): Relationship between clinical uterine findings, therapy, and fertility in the mare. Vet. Sci.. 10, 259.

https://doi.org/10.3390/vetsci10040259

SPENCER K. M., G. PODICO, A. A. MEGAHED, K. L. JONES, J. H. BITTAR, I. F. CANISSO (2022): Ovulatory response to GnRH agonist during early and late fall in mares. Theriogenology 185, 140-148.

https://doi.org/10.1016/j.theriogenology.2022.03.003

TRAVERSARI, J., H. AEPLI, B. KNUTTI, J. LUTTGENAU, R. BRUCKMAIER, H. BOLLWAIN (2019): Relationships between antral follicle count, blood serum concentration of anti-Müllerian hormone and fertility in mares. Schweiz. Arch. Tierheilkd. 161, 627-663.

https://doi.org/10.17236/sat00225

WARRIACH, H. M., M. A. MEMON, N. AHMAD, S. T. NORMAN, A. GHAFAR, M. ARIF (2014): Reproductive performance of Arabian and Thoroughbred mares under subtropical conditions of Pakistan. Asian-Australas. J. Anim. Sci. 27, 932-936.

https://doi.org/10.5713/ajas.2013.13547

WATSON E. D., R. THOMASSEN, E. NIKOLAKOPOULOS (2003): Association of uterine edema with follicle waves around the onset of the breeding season. Theriogenology 59, 1181-1187.

https://doi.org/10.1016/s0093-691x(02)01161-5

TIRPAN, M. B., K. T. OLĞAÇ, M. O. ŞAHIN, U. KAYA: Stope gravidnosti s obzirom na promjer folikula i edema endometrija tijekom dvije uzastopne ovulacije kobila arapske pasmine različitih dobnih skupina. Vet. arhiv 94, 173-182, 2024.

SAŽETAK

Cilj je istraživanja bio procijeniti stope gravidnosti u kobila različitih dobnih skupina na temelju promjera folikula i edema endometrija za vrijeme dviju uzastopnih ovulacija u tri sezone parenja. Trideset kobila arapske pasmine podijeljeno je u dvije skupine: dobna skupina do 10 godina, uključujući i desetogodišnje kobile (skupina A=54), i dobna skupina iznad 10 godina (skupina B=36). Tijekom rasplodne sezone bilježeni su promjer folikula i edem endometrija. Nakon prve ovulacije, kada je analiziran promjer folikula u svih kobila u skupinama A i B, neovisno o dobi, te su uspoređene gravidne i negravidne kobile, nije bilo znakovitih razlika (P>0,05). Nije bilo znakovitih razlika ni s obzirom na dobnu skupinu (P>0,05). Pri drugoj je ovulaciji uočena znakovita razlika (P<0,05) u promjeru folikula između gravidnih i negravidnih kobila. Nije bilo znakovite razlike (P>0,05) u stopi gravidnosti s obzirom na dob kobila. U dvije uzastopne ovulacije nije uočena znakovita razlika s obzirom na edem endometrija u gravidnih i negravidnih kobila (P>0,05). Može se zaključiti da premda promjer predovulacijskog folikula nije pouzdan pokazatelj u otkrivanju gravidnosti, on je i dalje važan za određivanje vremena ovulacije i umjetnog osjemenjivanja. Edem endometrija koristan je samo u određivanju vremena inseminacije i nije povezan s gravidnošću. Također, s obzirom na to da su u različitim dobnim skupinama uočene slične stope gravidnosti, sama dob nije dovoljan pokazatelj reproduktivne učinkovitosti u kobila.

Ključne riječi: promjer folikula; ovulacija; kobila; edem endometrija