Factors Concerning Early Embryonic Death in Thoroughbred Mares in South Korea

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ABSTRACT. A total of 384 Thoroughbred mares were investigated to determine and evaluate the features of early embryonic death at nine equine farms on Jeju Island, South Korea, from 2001 to 2003. Overall, 771 matings for 384 mares resulted in 376 pregnancies 15 days after ovulation. Subsequently, 12.2% (46/376) of these early conceptuses were lost within 45 days after ovulation. Furthermore, about three quarters of the 46 embryonic deaths occurred between 16 and 25 days after ovulation. The incidence of embryonic death was highest in the barren (17.2%), more than 15 years old (15.4%), and more than 10 parities (18.2%) groups compared with the other groups (9.1–16.9%). Mares mated in March, April, and during the first estrus postpartum had higher embryonic death rates, (19.6%, 17.2%, and 24.6%, respectively). Mares with abnormal fluid and cysts in the uterus (18.0%) or multiple embryonic vesicles (23.1%) had higher embryonic death rates than those with normal uterine conditions (9.8%) or single embryonic vesicles (10.5%). The condition of mares, such as breeding condition and the environment of the embryo or fetus, are the major factors in relation to occurrence of early embryonic death.

KEY WORDS: breeding condition, embryonic death, Thoroughbred, uterine environment.

Horses are long-day breeders and have lower reproductive efficiency compared with sheep and cows [32]. The fertility of mares depends on their individual fertility status. Some mares show total fertility rates of 90% if they are highly fertile, while ordinary mares have total fertility rates ranging from 81% to 92%, which are still higher than those of other animals [2, 3]. Sullivan et al. [31] reported a four-year cumulative pregnancy rate of 74% for Thoroughbred breeding, which was lower than the 85% rate for Quarter horses. Bruck et al. [4] stated that 85% of Thoroughbred mares achieve pregnancy and 69.3% of them give birth to live foals. Rose and Hodgson [25] reported that Thoroughbred mares worldwide have a foaling rate ranging from 60% to 70% on average. Davies Morel [7] suggested that the foaling rates of Thoroughbred mares range from 50% to 80%. Thus, Thoroughbred mares have proven low reproductive efficiency despite their high pregnancy rates. Furthermore, high embryonic mortality is cited as the main reason for low reproduction [7, 32].

Reproductive dysfunction in mares is closely linked to low fertility caused by improper care and maintenance, artificial control of breeding season, and hormonal and genital disorders [5, 7]. In addition, the morphology and diameter of the fetus are important factors for pregnancy and embryonic death rate of mares [5, 7]. Embryonic death in mares is primarily associated with genetic and environmental factors [3, 21, 29, 32]. Vaginal infections and other uterine abnormalities have a particularly significant impact on premature loss of the fetus by failing to meet the metabolic needs of pregnancy [3, 21, 29, 32]. At the same time, irregular and unbalanced nutrition and psychological stress resulting from their roles in the areas of transportation and horse racing also cause early embryonic death in mares [15, 24, 36]. Taking these pregnancy risk factors into consideration, the role of clinical veterinarians appears essential for promotion of breeding efficiency in mares.

The purpose of this study was to determine the major variables related to early embryonic death in Thoroughbred mares in an effort to enhance reproductive efficiency in equine breeding by minimizing failure of pregnancy maintenance. The aim of this study was also to serve as a cornerstone of veterinary efforts to optimize fertility in mares.

MATERIALS AND METHODS

Animals: A total of 384 Thoroughbred mares at nine equine ranches on Jeju Island, South Korea, were examined from March 2001 to July 2003. The mean age and number of parities of the mares were 10.4 (1–13) and 4.9 (3–21), respectively.

Diagnosis and analysis: Diagnosis was primarily performed by palpation per rectum and by transrectal ultrasonography using a 5.0 MHz transducer (Aloka, Tokyo, Japan).

The reproductive tract was checked before mating, and ovulation was confirmed 2 days after mating. Pregnancy was examined 15 days after ovulation (the day ovulation was confirmed was considered day 0), and embryonic death was examined 25 and 45 days after ovulation, respectively. Pregnancy diagnosis was carried out during the breeding season to determine whether mares were pregnant or not (experienced embryonic loss) so that they could be recovered by a stallion at their next estrus if necessary. When ultrasonography revealed that a mare had either an intrauter-
ine cyst of more than 0.5 in diameter or abnormal intrauterine fluid, the results were recorded as intrauterine foreign bodies, which are detectable both before and after mating. The data collected during the breeding season for three years included pregnancy rates (100 times the number of mares pregnant divided by number of mares served) and embryonic death rates (100 times of number of mares showed embryonic death divided by number of mares pregnant) related to age, parity, breeding condition, and uterine environment. To avoid confusion, embryonic death was defined in this study as loss of a conceptus, embryo, or early fetus. Data were analysed using the Chi-square test and considered significant at P<0.01.

RESULTS

Embryonic death in overall broodmares: The average mating was calculated as 2.0 times per estrus in the mares subjected to this study. The fertility rate was 97.9% (376 out of 384) when pregnancy was confirmed 15 days after ovulation. Forty-six of the 46 mares (12.2%) lost their embryos within 45 days post-ovulation (Table 1).

Embryonic death related to breeding condition: Analysis of early embryonic death related to the mare condition showed that relatively higher mortality (17.2%) occurred in mares with a history of being barren during the previous season (5 out of 19 cases) compared with foaling and maiden mares in the previous season. The lowest embryonic death rate (9.8%) occurred in mares that experienced abortion or stillbirth during the previous breeding season (6/61; Table 2).

The data concerning early embryonic death related to age and reproductive history is presented in Table 3. The incidence of embryonic death in mares belonging to the 7 to 10 and above 15 years age groups and those with 1 to 3 or more than 10 parities was higher than the average mortality. The embryonic death rate among mares in the 11 to 14 age group and those with 7 to 9 parities were 11.0% (16/145) and 9.1% (11/121), respectively, with the latter being the lowest.

Embryonic death related to breeding season: The relationship between embryonic death and breeding month of the year is presented in Table 4. Much higher incidences of embryonic death were observed in March (19.6%, 11/56) and April (17.2%, 20/116). However, the average mortality gradually decreased by May and June.

The reproductive performance of the 261 mares that successfully delivered foals normally in the spring of the preceding season is presented in Table 5 based on the number of estrus services. The highest rate of embryonic death (24.6%, 17/69) was observed in mares that conceived at the first postpartum estrus, regardless of their body condition and uterine environment. This rate was more than two times the average mortality of 12.2% and was three times the rates of the second and third estruses postpartum (8.2% and 7.4%).

Embryonic death related to uterine environment: The relationship between embryonic death and intrauterine abnormal fluid accumulation or cysts is presented in Table 6. The rates of embryonic death in mares with intrauterine abnormal fluid and cysts, whether they were present alone or together, were not significantly different. The mean incidence of embryonic death among mares with uterine abnormality was 18.0% (20/111) and was about twice (9.8%, 26/265) that of mares with no uterine abnormalities.

Embryonic death related to embryonic vesicles: The relationship between embryonic death and the number of embryonic vesicles is shown in Table 7. The embryonic death rate in mares with multiple vesicles was 23.1% (12/52) and was more than twice (10.5%) that in mares with a single vesicle. Among mares with multiple vesicles, those with three vesicles triple had a higher incidence of embryonic death (66.7%, 2/3) compared with the mortality rate (20.4%, 10/49) in mares with two vesicles; this shows that those is a correlation between the number of vesicles and embryonic death.

The time of occurrence of embryonic death in pregnancies is presented in relation to single and multiple embry-
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Three-quarters of the total number of embryonic deaths (35/46 cases) were detected within 25 days after ovulation, indicating that embryonic death occurred between 16 and 25 days after ovulation. The loss rates occurred between 16 and 25 days after ovulation were 58.7% (27/46) and 17.4% (8/46) in pregnancies with a single embryo or multiple embryos, respectively, accounting for 76.1% (35/46) of the total losses detected in the first examination after the pregnancy diagnosis.

DISCUSSION

Early embryonic death in mares can be triggered by an array of factors, including hormone deficiencies, genetic causes, uterine infection, twin pregnancy, and lactational stress [2, 6, 14, 29, 32]. Late embryonic death can be caused by failure of normal placentation, placental dysfunction, and acute and chronic stress resulting from microorganism infection, endocrine dysfunction, and twin pregnancy [10, 27, 28, 30].

The present study showed that the mean frequency of mating was 2.0 times per estrus (771 matings in total for 384 estrus). The pregnancy rate was 97.9% (376 pregnant mares/384 mating mares). The mares subjected to this study showed good reproductive performance with a higher frequency of mating and higher fertility rate.

The present investigations showed that 12.2% (46/376) of embryos were lost between days 15 and 45 after ovulation. Furthermore, a higher rate of embryonic death was observed in mares with a history of being barren in the previous season (17.2%), mares having more than 10 parities (15.4%), and mares over 15 years of age (18.2%). Embryonic death can occur at any time during gestation, although its frequency may vary depending on investigation with different methods, age of the mares, horse breed, and fertility status of the mares [21]. The rates of embryonic death reported in the literature vary greatly and include such rates as 5 to 24% [3], 5 to 30% [14], and 13.3% [37]. Carnervale et al. [5] suggested a 15.5% embryonic death rate between days 12 and 50 after embryo transfer.

A study of Thoroughbred mares at six equine ranches in southeast Australia [4] showed that the embryonic death rates of foaling mares, barren mares, and maiden mares were 20.9%, 19.7%, and 12.4%, respectively. A study of Thoroughbred mares in Kentucky in the United States presented an early embryonic death rate of 18.0% for foaling mares.
mares and 42.0% for barren and maiden mares within 40 days after ovulation, showing a significant difference between the two groups [19]. A 12 years study of Thoroughbred mares in the eastern part of South Africa reported that the embryonic death rate of foaling mares was higher (12.6%), compared those of barren (7.0%) and maiden mares (4.0%). The same study also stated that the embryonic death rate of mares whose fetuses were located in previously gravid horn was more than twice the mortality rate of mares whose conceptuses were attached in the horn opposite to the previously gravid horn [8]. Thus, location of the fetus in the same uterine horn appears to have a negative impact on fetal development and might eventually cause fetal loss.

The age of mares has a significant influence on their fertility status, and the effects of age in mares stands out compared with those in other species [3, 7]. Older mares tend to have a greater risk of early embryonic death due to reduced oocyte viability. Furthermore, repeated pregnancy, particularly reduction of myometrial activity and loosened uterine ligaments, cause other degenerative changes in the uterus and lead to an increase in embryonic loss and a decrease in pregnancy rate [11, 20, 21]. Morris and Allen [20] reported that the rate of embryonic death between days 15 and 35 after ovulation is higher in mares aged 9 to 13 years old and is more that twice the rate of mares aged 3 to 8 years old. Woods et al. [37] suggested that the lowest rate of embryonic death is found in mares aged 10 to 13 years old, while the highest rate of embryonic death is found in mares aged 21 years or older. Carnevale et al. [5] reported loss in 63% of mares aged 15 years or older. The present study showed that mares aged 11 to 14 years and those with a reproductive history of 7 to 9 parities had better reproductive performance, with embryonic death rates of 11.0% and 9.1%, respectively, compared with the other groups. On the other hand, older mares aged 15 years or older and those having a reproductive history of more than 15 parities exhibited embryonic death rates of 15.4% and 18.2%, respectively. Therefore, the age and reproductive history of mares can be considered to be the significant factors in selection of broodmares to enhance reproductive efficiency.

A study of loss of embryos lasting longer than 40 days post-ovulation in mares in Kentucky, United States, identified that embryonic loss was greater in young fertile or barren mares compared with old, foaling, or maiden mares. Furthermore, the varying degree of care and maintenance of mares among ranches and breeding during February and March prior to the breeding season were cited as the main reasons for these results [19]. Mares that were bred before the breeding season, which starts in late April in the northern hemisphere, had a greater risk of embryonic death as they were exposed to drastic environmental changes, and mares that were bred using artificial insemination techniques, such as light arrangement also had a lower fertility rate than their naturally bred counterparts [7, 32]. Analysis of the relationship between embryonic death and breeding season in this study revealed that breeding was most successful during April and May, although the embryonic death rate was also high. However, embryonic death was highest in mares bred in March, and the rate decreased as the breeding season advanced. Breeding after the first ovulation before 20 day postpartum resulted in lower pregnancy rates and embryonic survival than breeding during the second heat postpartum due to the delay in uterine contraction and intrauterine fluid accumulation [9, 12, 14, 17, 21]. These results promote the need for careful evaluation of the body condition of mares if they are to be bred at the first estrus postpartum or if they are bred at the beginning of the breeding season.

It has been speculated that cysts located in the uterus interfere with embryo migration in the uterine lumen and block the signal for maternal recognition of pregnancy. This suggests early embryonic death may occur as an effect, indicating reduction of the fertility of Thoroughbred mares [7, 12, 14, 15, 21, 35]. At the same time, mares with intrauterine fluid are less likely to become pregnant or they lose their embryos more often compared with mares having uterine clearance because abnormal uterine fluid cause uterine infections and impinge on normal movement of sperm [1, 2, 11, 12, 14, 15, 21–23, 33, 34]. Approximately 15% of Thoroughbred mares are known to have intrauterine fluid accumulation after breeding [38]. Based on the analysis of the impact of an ultrasound-detected abnormal uterine environment on embryonic death, mares with intrauterine fluid accumulation and the presence of multiple large cysts exhibited embryonic death rate of 18%, which was almost twice that observed in normal mares (9.8%). Thus, the uterine environment appears to be significantly important for conception as it is closely associated with successful implantation of embryos, fetal growth, development, and even embryonic loss.

Multiple pregnancies, which usually occur in 2% of Thoroughbred mares, have a role in causing abortion, stillbirth, and infertility [7, 18, 26]. Multiple pregnancies usually result in abortion, stillbirth, birth of malformed foals, difficult labor, or tissue damage to the birth canal. As a means of preventing these side effects, multiple pregnancies can be manually reduced to a single embryo by performing a selective reduction procedure this has a 90% success rate when performed before the placenta is formed. However, rough handling can result in complete embryonic death [13, 15, 16, 21, 24, 28]. In a study of early embryonic death in mares bred in 1985 that was based on the number of embryonic vesicles, Woods et al. [37] reported that the early embryonic death rate for multiple pregnancies (24.4%, 10/41) was greater than for single pregnancies (12.5%, 70/559). The present study identified an embryonic death rate of 23.1% (12/52) in multiple pregnancies and 10.5% in single pregnancies (34/324), and these figures are fairly consistent with the findings of the study mentioned above. This suggests that embryonic death in multiple pregnancies can be caused by the multifetal pregnancy reduction procedure. Most embryonic deaths occur within 40 days after conception. Morris and Allen [20] reported that the incidence of fetal...
loss in Thoroughbred mares in New Market, England, was 17.4% (199/1145) throughout the gestation period and that the embryonic death rate between days 15 and 35 after ovulation was 10.4% (119/1,145). Woods et al. [37] reported that the early fetal loss rate for mares bred in 1985 was 13.3% (80/600) throughout the entire pregnancy and that the early fetal loss rate for mares bred in 1985 was 10.4% (119/1,145). The role of veterinarians need to ensure that mares are in optimum condition for breeding by evaluating their body condition characteristically taking place.

In summary, fetal loss in Thoroughbred broodmares is attributable, directly or indirectly, to a wide range of factors, including fertilization status, breeding condition characterized by age and reproductive history, postpartum breeding timing, uterine environment, and embryonic condition. Therefore, veterinarians need to ensure that mares are in optimum condition for breeding by evaluating their body conditions, especially their uterine conditions. The role of veterinarians seems very important for reduction of early embryonic death and enhancement of conception in mares.

REFERENCES


