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Foaling rate of mares that were rebred after pregnancy loss in Hidaka, Japan

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The purpose of this study was to evaluate foaling rates of mares that were rebred after the pregnancy loss in same reproductive season and to examine factors influencing them in Hidaka, Japan. The study included 82 Thoroughbred mares that had experienced pregnancy loss. The foaling rate of the mares that were rebred after pregnancy loss was 57.3%. The foaling rate decreased as the period until detection of pregnancy loss increased. Aging and lower body condition score of mares decreased the foaling rate.

Key words: equine reproduction, foaling rate, mare, pregnancy loss, Thoroughbred

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Since the Thoroughbred mating season is of limited duration and Thoroughbred horses are valued highly, breeders desire high pregnancy and foaling rates. Pregnancy loss is one important factor that reduces reproductive efficiency [2, 5], with early embryonic failure in particular resulting in considerable economic loss to the equine industry due to the increased costs associated with additional breeding of mares and/or decreased foal production [20]. Rates of early pregnancy loss range from 3.0 to 12.2% [2, 9, 13, 15, 21], varying between countries and regions (e.g., 5.8% in Hidaka, Japan [14], 7.4% in Newmarket, England [2], Kentucky, 8.9% in United States [5], 12.2% in South Korea), and it has been demonstrated that pregnancy loss is inevitable in some mares [2, 5, 21]. Vanderwall and Newcombe [20] suggested that an important aspect of the clinical management of pregnancy loss is early diagnosis

so that rebreeding is facilitated as soon as possible [20]. However, the foaling rates of mares that are rebred in the same reproductive season after pregnancy loss are unclear. Therefore, the purpose of this study was to evaluate these foaling rates and examine which factors influence them.

A prospective cohort study was conducted among 82 Thoroughbred mares (4–18 years old) in Hidaka, Japan, that had experienced early pregnancy loss. All of the mares were mated in the three mating seasons from 2007 to 2009. Each mare was subjected to transrectal ultrasonography for pregnancy diagnosis on around day 17 after the last mating (interquartile range=day 16–18), which confirmed pregnancy. Pregnancy loss was then detected in each mare by ultrasonography on day 26–60. Here, we defined the mares as foaling or non-foaling based on whether or not a foal was successfully produced in the following spring when they were rebred after pregnancy loss in the same reproductive season.

The following reproductive records were collected for each mare: age, reproductive status (maiden [never mated], barren [not pregnant at the end of the previous season or experienced pregnancy loss before the following season], or foaling [foaled and lactated during the season]), and body condition score (BCS) at the first diagnosis and the time of

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detecting pregnancy loss (determined by a veterinarian in accordance with Henneke *et al.* [10]). Fisher's exact tests were then used to ascertain which of the factors among mare's age, reproductive status, the duration between pregnancy loss and mating, and BCS affected foaling success following rebreeding, with a *P* value of <0.05 considered statistically significant.

In total, 47 of the 82 mares delivered a live foal following rebreeding after pregnancy loss, giving a foaling rate of 57.3%. The average day on which pregnancy loss was detected was day 36 ± 7.7 (mean \pm standard deviation), while the median was day 34 (interquartile range=day 30 to 38). The foaling rate decreased as the time until detection of pregnancy loss increased (Table 1), but the differences were not significant (*P*>0.05).

The average age of the mares was 10.8 ± 3.7 years old, while the median was 11 years old (interquartile range=8–14 years old). The foaling rate tended to decrease with increasing age of the mares (Table 2), with a significant difference between the 3–8 years old and 14–18 years old mares (*P*=0.039). There were, however, no significant differences in foaling rate between the 9–13 years old mares and the mares of the other two age groups.

We obtained BCS data from 57 of the 82 mares. The foaling rate of mares with a BCS ≥ 5.5 at the time of detecting pregnancy loss was 71.4%, whereas that of mares with a BCS <5.5 was 52.2% (Table 3). The difference, however, was not significant. Mare reproductive status (i.e., maiden, barren, or foaling) was recorded for 81 of the mares and was not related to the foaling rate (*P*>0.05).

The observed foaling rate of the mares following rebreeding in the same reproductive season after pregnancy loss (57.3%) was lower than the foaling rates of 69–79% that have been reported in previous studies on Thoroughbred mares [2, 5]. However, it was still relatively good considering that all of the mares had experienced pregnancy loss. To the best of the authors' knowledge, this is the first study to investigate the foaling rate in mares following pregnancy loss.

The majority (76.1%) of early embryonic losses occur prior to day 25 post ovulation [21]. Pycocock [18] suggested that ultrasound examinations should be performed 26 to 30 days after covering to allow the veterinarian to check for normal development and to rule out the presence of twins. However, in the present study, the average day of detecting pregnancy loss was day 36, while the median was day 34, indicating that conducting ultrasound examinations earlier than this, e.g., around day 28, would allow pregnancy loss to be detected as soon as possible.

Mares in which pregnancy loss was detected after day 35 had low foaling rates, supporting the previous findings of Penzhorn *et al.* [17]. This may indicate that equine chorionic gonadotropin, which is produced by the endometrial cup

Table 1. Effect of the day pregnancy loss was detected after mating on foaling rate

Day pregnancy loss was detected after mating	Foaling rate (%) (foaling/total)
<Day 29	66.7 (8/12)
Days 29–35	62.5 (25/40)
Days 36–42	50.0 (8/16)
>Day 42	42.9 (6/14)
Total	57.3 (47/82)

Table 2. Effect of age groups on foaling rate

Age groups (year)	Foaling rate (%) (foaling/total)
3–8	74.1 (20/27) ^a
9–13	52.9 (18/34)
14–18	42.9 (9/21) ^b
Total	57.3 (47/82)

^{a, b}Values in the same column with superscripts are significantly different (Fisher's exact test *P*<0.05)

Table 3. Effect of body condition score at pregnancy loss on foaling rate

Body condition score	Foaling rate (%) (foaling/total)
≥ 5.5	73.5 (25/34)
<5.5	52.2 (12/23)
Unknown	40.0 (10/25)
Total	57.3 (47/82)

[8], prevents mares from returning to normal estrus. The endometrial cup is formed by hypertrophy of the endometrial glands and the subsequent invasion of the endometrium by chorionic epithelial cells [3], and it starts to develop at around day 37 of gestation [4]. Mares that experience pregnancy loss after endometrial cup formation may continue to produce progesterone from the accessory corpora lutea in response to the continued secretion of equine chorionic gonadotropin [12]. Consequently, Pycocock [18] argued that if examination is delayed until after day 33, endometrial cup activity may prevent the normal estrous cycle from returning for the rest of the breeding season. Similarly, Baucus *et al.* [4] suggested that pregnancy loss after 35 days is commonly associated with difficulties in recycling the mare due to endometrial cup activity. Therefore, the results of the present study imply that transrectal ultrasonography should be performed before day 35 from a clinical perspective.

Mare age has been shown to influence both pregnancy rates and pregnancy loss rates [1, 2, 5, 15]. Similarly, in the present study, younger mares (3–8 years old) achieved higher foaling rates than older mares (14–18 years old). This may be due to the onset of age-related degenerative changes in the endometrium, which reduce its nutritive capacity

for the developing conceptus [6, 19]. In addition, uterine contractility and uterine tone decrease, and fixation of the embryonic vesicle occurs later in older mares [7], which may reduce the likelihood of the mares becoming pregnant.

It has previously been found that poor body condition in mares within the first 90 days after foaling is associated with reduced pregnancy rates and higher pregnancy loss rates [11, 14] and that nutrition also has a significant effect on pregnancy loss in mares [16]. The results of the present study add to these findings by showing that if mares do suffer pregnancy loss, adequate body condition (≥ 5.5) helps them to become pregnant again.

In conclusion, this study demonstrated that 57.3% of mares that were rebred after pregnancy loss successfully produced a live foal the following spring. An important aspect of the clinical management of pregnancy loss is its early diagnosis to provide an opportunity for rebreeding as soon as possible. This can best be accomplished by performing serial examinations with transrectal ultrasonography at least twice after the first examination, e.g., on days 28 and 35.

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