

Relationship between the Placental Retention Time and the Reproductive Performance at the Foal Heat in Thoroughbred and a Comparison with Heavy Draft

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The aim of this study was to clarify the relationship between the placental retention time (PRT) and the reproductive performance following mating at the foal heat in Thoroughbreds. For this purpose, we interviewed 292 farmers over a period of 3 years with questionnaires evaluating foaling, expulsion of placenta and reproductive performance at the foal heat in 1,432 mares. The obtained data were later compared with a previous study of heavy draft mares. The average of the PRT of the 1,432 Thoroughbred mares was 58 ± 88 min (mean \pm SD). The mean PRT of Thoroughbreds was significantly shorter than that of the 148 min of heavy draft mares. The incidences of retained placenta (RP) occurring in the Thoroughbred mares were 5.2 and 4.0%, for over 3 and 4 hr after foaling, respectively. The incidence of RP over 4 hr was significantly lower than that of 25% in heavy draft mares. The pregnancy rate at foal heat of the mares in which PRT was less than 3 hr was 37%, and it significantly decreased to 11% for those with PRT of more than 3 hr. In the comparison of the reproductive performance between Thoroughbred and heavy draft mares, the pregnancy rate of Thoroughbreds dropped drastically to 10% when PRT exceeded 40, and in consequence, the pregnancy rate of Thoroughbreds was significantly lower than the 30% of heavy draft mares, which had a PRT of over 4 hr. In conclusion, the Thoroughbred mares had a low incidence of RP, however, a PRT exceeding 3 hr severely affected the reproductive performance at the foal heat.

Key words: foaling, heavy draft, placental retention time, reproductive performance, Thoroughbred

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Retained placenta (RP) is reported to be the most common postpartum problem in mares. It can cause puerperal fever, laminitis, septicemia and death. Although RP has been variously suggested to be caused by dystocia [16], infection [12], edema of placenta [4], uterine inertia due to hormonal imbalance, e.g. oxytocin or prostaglandin $F_{2\alpha}$ [6, 7, 16], and vitamin E and selenium deficiency [8], the

process that leads to RP is still unclear. The postpartum time interval for definition of RP varies from author to author, and has been reported as 30 min [12], 1 hr [9, 16] 2 hr [15], 3 hr [1, 3, 10, 13, 14] and 6 to 12 hr [18]. The incidence of RP is difficult to assess because of a lack of a specific postpartum time interval in the definition, but has been reported to range between 2 and 54% in foaling [11, 13, 17]. Expulsion of the placenta by mares generally occurs rapidly with a mean of approximately one hour [3, 10]. We previously reported that the mean of placental retention time (PRT) in heavy draft mares was 148 min,

and the incidence of RP, defined as over 4 hr after foaling, was 25% [5]. In addition, the incidence of RP over 3 hr in Friesians after foaling was reported as 54% [13]. Therefore, the PRT and the incidence of RP in mares vary from breed to breed.

We previously reported that the pregnancy rate of heavy draft mares (hereafter, heavy draft) following mating at the foal heat decreased with an increase in PRT [5, 9]. When PRT was less than 1 hr, from 1 to less than 4 hr and over 4 hr, the conception rates following mating at the foal heat decreased significantly from 66%, to 60% and 52%, respectively [5].

The aim of this study was to clarify the relationship between PRT and the reproductive performance following mating at the foal heat. For this purpose, we interviewed 292 farmers with a questionnaire evaluating foaling, expulsion of placenta and reproductive performance at the foal heat in a survey of 1,432 mares in Hokkaido, the main Thoroughbred breeding area in Japan.

Materials and Methods

This study was conducted on 292 farms in the Hidaka district of Hokkaido, Japan, over a period of 3 years. A total of 1,432 Thoroughbred mares (hereafter, Thoroughbred) for which the PRT was recorded were surveyed. The ages of the mares varied from 4 to 20 years old. The situation of foaling, the expulsion of placenta and the reproductive performance following mating at the foal heat of the mares were also recorded. Mares from which RP was removed manually were excluded from the calculation of PRT. Mares bred up to 21 days after foaling were used to calculate the mating rate, conception rate and pregnancy rate at the foal heat. The mating rate was defined as the percentage of mares mated at foal heat per total mares. Mares which foaled in January or February, and had the possibility of foaling within the same year, were excluded from the total number of mares. The conception rate was defined as the percentage of mares which conceived following mating at the foal heat per total of mares mated at the foal heat. The pregnancy rate was defined as the percentage of mares which became pregnant following mating at the foal heat per total number of mares bred during the breeding season. Natural mating was used for all mares. Mares were mated at a suitable time, after the condition of estrus. Ovarian follicle and ovulation at the foal heat were checked by a veterinarian via rectal palpation or ultrasound examination. Pregnancy diagnosis was performed at around 14 days post-ovulation and normal development of the embryonic vesicle was detected at around 28 days post-ovulation.

The mating, conception, and pregnancy rates were

compared among PRT intervals, in order to analyze the influence of PRT on the reproductive performance following mating at the foal heat. The present study's data for distribution of Thoroughbred mares and reproductive performance categorized by PRT were compared with our previously reported data for 422 heavy draft foaling mares, which was collected in the Kushiro area of Hokkaido, from 1991 to 1994.

All data were analyzed statistically. To calculate the mean PRT, cases lasting longer than 720 min were considered as being 720 min. Mares which were voluntarily controlled to skip the mating, were excluded from the analysis of mating rate at the foal heat. The differences in reproductive performances were compared across PRT categories using Tukey's method. The differences in reproductive performances of Thoroughbred and heavy draft were tested using a 2×2 contingency table and the χ^2 -test. The differences of PRT among ages were analyzed using the Tukey-Kramer method. Statistical significance was accepted for values of $P < 0.05$.

Results

Placental retention time (PRT)

The average of the PRT of the 1,432 Thoroughbred was 58 ± 88 min (mean \pm SD) and the median was 30 min (25%: 26 min, 75%: 60 min, in a range of 0 to 720 min). During the 30 min to 1 hr after foaling, which was the peak period of placenta expulsion, 45.7% of the mares expelled placenta, and 71.3 and 91.3% of the mares expelled placenta up to 1 and 2 hr after foaling, respectively. The incidences of RP were 5.2 and 4.1% for over 3 and 4 hr

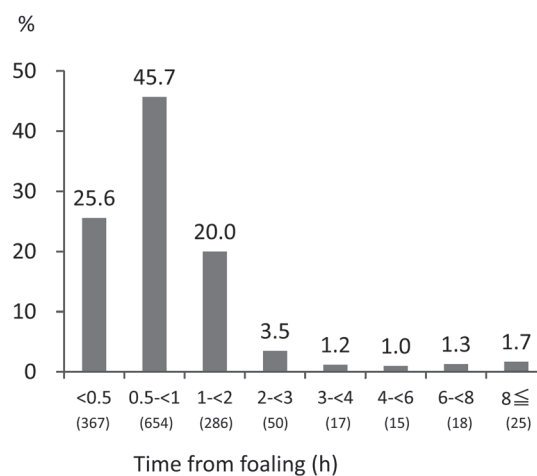


Fig. 1. Distribution of Thoroughbred mares according to PRT. (): Number of mares.

after foaling, respectively (Fig. 1). A total of 10 mares had their placenta removed manually. The age of mares had no significant effect on PRT.

Reproductive performance according to PRT

Although the mating rate at the foal heat of the mares with a PRT of less than 3 hr was constant around 80%, when PRT exceeded 3 hr, the mating rate reduced to the level of 60%, and it showed a further significant reduction to 50% for mares with a PRT over 6 hr after foaling ($P<0.01$) (Fig. 2).

The highest conception rate (52%) following mating at the foal heat was recorded for mares with PRTs of less than 30 min, and a high rate of 50% was recorded for PRTs of less than 3 hr. However, when the PRT exceeded 3 hr, the conception rate significantly and drastically declined to below 20% ($P<0.05$).

The pregnancy rate at the foal heat was below 40% for PRTs of less than 3 hr. PRT exceeding 3 hr, the pregnancy rate significantly reduced to around 10% ($P<0.05$).

Comparison of Thoroughbred with heavy draft

The mean PRT of 58 min of Thoroughbred was significantly shorter than the 148 min of heavy draft ($P<0.01$). The proportion of Thoroughbred which expelled placenta up to 1 hr after foaling was significantly higher than heavy draft ($P<0.01$), and the proportion of Thoroughbred which expelled placenta over 1 hr was significantly lower than heavy draft ($P<0.01$) (Fig. 3).

For the comparison of reproductive performance between Thoroughbred and heavy draft, the mares in this study were divided into 3 groups according to PRT in the same way as our previous report [5]: less than 1 hr, 1 to less than 4 hr, and over 4 hr. Although the mating rate at the foal heat of Thoroughbred was significantly higher than heavy draft before 4 hr ($P<0.05$), after 4 hr it decreased to a level similar to heavy draft. The conception rates of the PRT group of Thoroughbred were significantly lower than those of heavy draft (<1 hr: $P<0.01$) (1 to <4 hr: $P<0.05$). Especially in the PRT exceeding 4 hr, the conception rate markedly decreased in Thoroughbred ($P<0.01$). The pregnancy rate of Thoroughbred which had a PRT of less than 1 hr was significantly lower than heavy draft ($P<0.05$). In heavy draft, the pregnancy rate decreased gradually with increasing PRT. The pregnancy rate of Thoroughbred dropped drastically when the PRT exceeded 4 hr, and in consequence, the pregnancy rate of Thoroughbred was significantly lower than that of heavy draft with a PRT of over 4 hr ($P<0.01$) (Fig. 4).

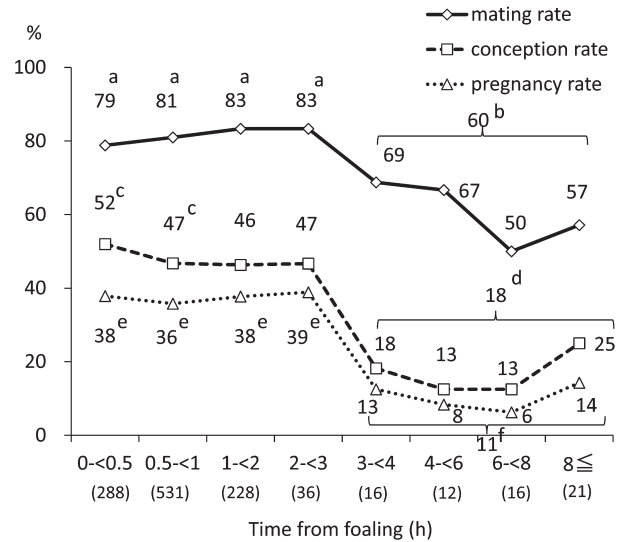


Fig. 2. Change in reproductive performance at the foal heat according to PRT. a vs. b, c vs. d, e vs. f: significant differences ($P<0.05$). (): Number of mares.

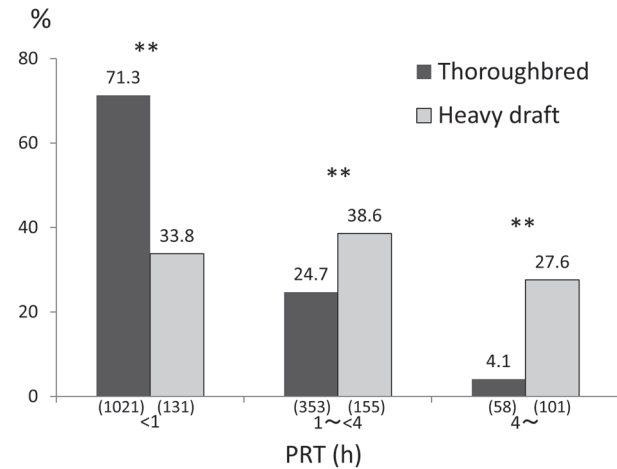


Fig. 3. The distribution of Thoroughbred and heavy draft according to PRT. **: Significant difference between Thoroughbred and heavy draft in the same PRT category ($P<0.05$). (): Number of mares.

Discussion

In this study, the mean PRT of 58 min of Thoroughbred was shorter than the 148 min of heavy draft [5]. The PRT of mares considerably differs across breeds. The mean PRT of Thoroughbred is similar to that of crossbred ponies, 60 min, and ranges from 5 to 180 min [10]. In this study, it was confirmed that Thoroughbred is one of the breeds in

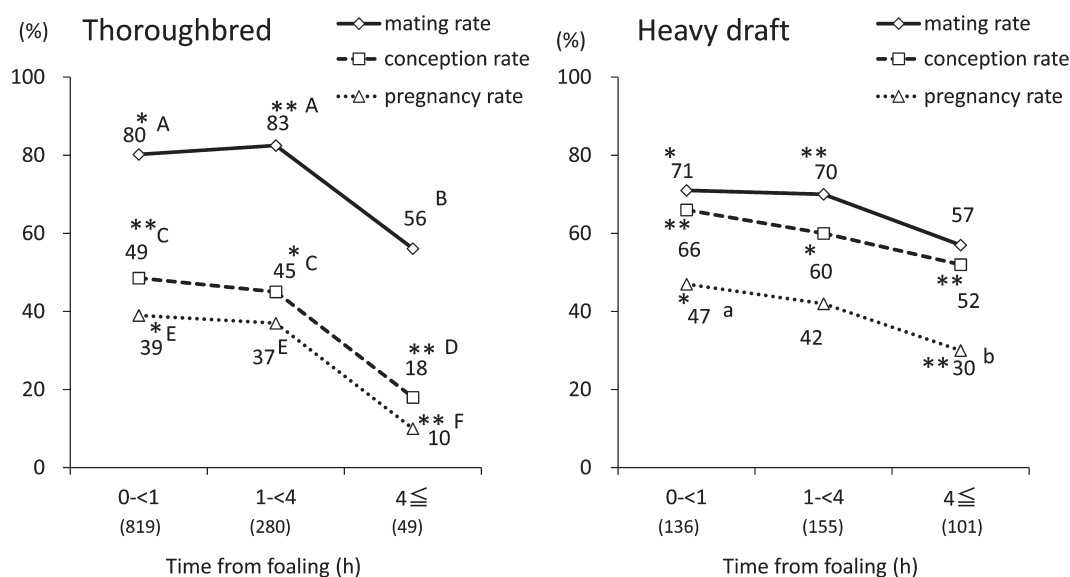


Fig. 4. Comparison of the reproductive performance of Thoroughbred and heavy draft at the foal heat according to PRT. A vs. B, C vs. D, E vs. F: significant differences ($P < 0.01$). a vs. b: significant difference between lowercase letters ($P < 0.05$). **: Significant difference between Thoroughbred and heavy draft ($P < 0.01$). *: Significant difference between Thoroughbred and heavy draft ($P < 0.05$). (): Number of mares.

which the placenta is expelled early after foaling.

The incidences of RP occurring in Thoroughbred were 5.2 and 4.0%, for over 3 and 4 hr after foaling, respectively. These rates are markedly lower than those of other heavy breeds: 27.6% for heavy draft for over 4 hr after foaling [5], and 54% for Freisian for over 3 hr after foaling [13]. These findings are in agreement with the observations of Cuervo-Arango and Newcombe [2], who noted that the incidence of RP varies from 6 to 54% depending on the breed, with higher incidence in heavy draft mares than in light-weight mares. Although the placental discharge mechanism has been studied, the reason for differences in PRT among breeds is still unknown. Future studies investigating the causes of RP will need to consider the features of each breed.

The reproductive performance decreased remarkably in Thoroughbred with PRTs exceeding 3 hr. In our previous report investigating the reproductive performance of heavy draft at the foal heat in relation to PRT, we found that the pregnancy rate following mating at the foal heat gradually reduced with PRT at durations longer than 1 hr, and that the mating rate significantly decreased after 4 hr of PRT [5]H. The 422 mares in our previous report were divided into 3 groups according to PRT: less than 1 hr, from 1 to less than 4 hr, and over 4 hr. In this study, as the number of mares was 1,432, we could investigate shorter PRT intervals, and created 8 groups based on PRT. We noted that all reproductive performances decreased drastically

for PRTs over 3 hr. As the mating and the conception rate were maintained at similar levels in Thoroughbreds with PRTs shorter than 3 hr, it can be considered that the influence of placental retention for less than 3 hr after foaling is minimal. However, when the PRT exceeds 3 hr, contamination in the uterus might induce uterine damage and delay of uterine involution, consequently decreasing the fertility at the foal heat. In Thoroughbred, it is possible to consider 3 hr after foaling as the crucial point for the development of functional abnormalities in the reproductive organs. From this point of view, the time for the definition of RP in Thoroughbred should be 3 hr after foaling.

We previously reported that aerobic bacteria were cultured in samples from the uterus of almost 100% of the mares for which PRT was longer than 8 hr compared with 47.2% for mares with a PRT of less than 8 hr [5]. Intrauterine swabs were taken from mares with potentially abnormal mucus or long PRT, 6 to 15 days after foaling and before they were mated. Although in this study, the reason why reproductive performances decreased in Thoroughbred with longer PRT is unclear, we speculate that uterine contamination or infection caused the decrease in fertility.

This study clarified that in Japan, Thoroughbred had a significantly higher mating rate and significantly lower conception and pregnancy rates than heavy draft at the foal heat. Probably the reason for the higher mating rate of Thoroughbred at the foal heat is the difference in the foal's

market profitability or the official capability test, between Thoroughbred and heavy draft. Thoroughbred farms need foals as early as possible in the next breeding season. Thoroughbred owners give their mares all possible clinical methods and examinations, in order to have them mate at the foal heat as much as possible, in order to generate profit. For example, uterine flushing is commonly done without any clinical need. Therefore, it is our concern that too early mating at the foal heat or unnecessary medical treatments are being performed. Actually, for Thoroughbred, the mating rate was higher but the conception and pregnancy rates were significantly lower than those of heavy draft. Only 18% of Thoroughbred with a PRT of over 4 hr after foaling conceived following mating at the foal heat, and their pregnancy rate was only 10%. These rates were significantly lower than heavy draft. From these results, we infer that the influence of RP on fertility at the foal heat in Thoroughbred might be more severe than in heavy draft. The reasons for the drastically decreased fertility of Thoroughbred with RP are still unknown, and they need to be clarified in further studies.

In conclusion, the average Thoroughbred PRT was 58 min, and the incidence of RP was 5.2% for over 3 hr after foaling. The reproductive performance decreased drastically in the mares which had RP, a PRT exceeding 3 hr, after foaling. Although Thoroughbred mares had a low incidence of RP, a PRT exceeding 3 hr, it severely affected their reproductive performance at the foal heat.

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References

1. Blanchard, T.L. and Varner, D.D. 1993. Therapy for retained placenta in the mare. *Vet. Med.* **88**: 5.
2. Cuervo-Arango, J. and Newcombe, J.R. 2009. The effect of manual removal of placenta immediately after foaling on subsequent fertility parameters in the mare. *J. Equine Vet. Sci.* **29**: 771–774.
3. Ginther, O.J. 1992. Parturition, puerperium, and puberty. pp. 457–473. *In: Reproductive Biology of the Mare Basic and Applied Aspects*, 2nd ed., Equiservices, Wisconsin.
4. Held, J.P. 1987. Retained fetal membranes. pp. 547–550. *In: Current Therapy in Equine Medicine* (Robinson, N.E. ed.), W.B. Saunders, Philadelphia.
5. Ishii, M., Jitsukawa, T., Shimamura, T., Utsumi, A., Endo, M., and Yamanoi, T. 1999. Effect of placental retention time and associated treatments on reproductive performance in heavy draft horses. *J. Equine Vet. Sci.* **19**: 117–121.
6. Ishii, M., Kobayashi, S., Acosta, T.J., Miki, W., Matsui, M., Yamanoi, T., Miyake, Y.-I., and Miyamoto, A. 2009. Effective oxytocin treatment on placental expulsion after foaling in heavy draft mares. *J. Vet. Med. Sci.* **71**: 293–297.
7. Ishii, M., Kobayashi, S., Acosta, T.J., Miki, W., Yamanoi, T., Matsui, M., Miyake, Y.-I., and Miyamoto, A. 2008. Relationship between peripartur plasma oxytocin and prostaglandin F_{2α} metabolite and placental expulsion time in heavy draft mares. *J. Reprod. Develop.* **54**: 270–274.
8. Ishii, M., Ogata, H., Shimizu, H., Takeuchi, Y., Nozawa, T., Yamamoto, Y., Okamoto, T., Shimamura, T., Utsumi, A., Jitsukawa, J., Endo, M., Fukuda, T., and Yamanoi, T. 2002. Effects of vitamin E and selenium administration on pregnant, heavy draft mares on placental retention time and reproductive performance and on white muscle disease in their foals. *J. Equine Vet. Sci.* **22**: 213–220.
9. Ishii, M., Shimamura, T., Utsumi, A., Jitsukawa, T., Endo, M., Fukuda, T., and Yamanoi, T. 2001. Reproductive performance and factors that decrease pregnancy rate in heavy draft horses bred at the foal heat. *J. Equine Vet. Sci.* **21**: 131–136.
10. Jeffcott, L.B. 1972. Observations on parturition in cross-bred pony mares. *Equine Vet. J.* **4**: 209–214.
11. Provencher, R., Threlfall, W.R., Murdick, P.W., and Wearly, W.K. 1988. Retained fetal membranes in the mare: a retrospective study. *Can. Vet. J.* **29**: 8.
12. Roberts, S. 1986. Postparturient infections and diseases. pp. 373–390. *In: Veterinary Obstetrics and Genital Diseases*, Vermont, Woodstock.
13. Sevinga, M., Barkema, H.W., Stryhn, H., and Hesselink J.W. 2004. Retained placenta in Friesian mares: incidence, and potential risk factors with special emphasis on gestational length. *Theriogenology* **61**: 851–859.
14. Sevinga, M., Vrijenhoek, T., Hesselink, J.W., Barkema, H.W., and Groen, A.F. 2004. Effect of inbreeding on the incidence of retained placenta in Friesian horses. *J. Anim. Sci.* **82**: 982–986.
15. Shipley, W.D. and Bergen, W.C. 1969. Care of the foaling mare and foal. *Vet. Med. Small Anim. Clin.* **64**: 63–70.
16. Threlfall, W.R. 1993. Retained placenta. pp. 614–621. *In: Equine Reproduction*, Lea & Febiger, Philadelphia.
17. Vandeplasseche, M., Spincemaille, J., and Bouters, R. 1971. Aetiology, pathogenesis and treatment of retained placenta in the mare. *Equine Vet. J.* **3**: 144–147.
18. Wright, J. 1943. Parturition in the mare. *J. Comp. Pathol.* **53**: 8.