Induction of Lactation and Adoption of Foals by Non-Parturient Mares

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We have developed a treatment protocol for the successful induction of lactation in mares. This treatment consists of estrogen, progesterone, and sulpiride administration for 1 wk. Mares with induced lactation are able to adopt and nurse a foal to weaning age. Authors' addresses: Equitechnic, Le Mesnil Vicomte, France (Daels); Physiology of Reproduction and Behavior, INRA, 37380 Nouzilly, France (Duchamp, Porter).

1. Introduction

The induction of lactation without the need of a preceding pregnancy could offer several practical and economical advantages. Lactation has been induced in ruminants using steroids (progesterone and estrogen) as a short-term treatment followed by a wide variety of drugs aimed at increasing prolactin secretion. These treatment protocols have resulted in lactation with milk production ranging between 25% and 82% of a physiological, post-partum lactation. As a general observation, an induced lactation does not start with a production of colostrum. Several products (domperidone and sulpiride) have been used in recent years to increase endogenous prolactin secretion in mares either to advance the onset of reproductive activity in the early spring or to counter the ill effects of fescue toxicosis in pregnant mares at term.

In the equine industry, there is an interest in systems that would allow us to produce colostrum independent of pregnancy. Also, the availability of foster mares for adoption of orphaned foals remains a critical issue. Motivated by these two demands, studies were undertaken by Chavatte-Palmer and Palmer to determine if lactation can be induced in the mare and if this induced lactation is apt to generate colostrum. These studies were conducted in collaboration with the French National Study and likely constitute the first successful attempt to induce lactation in the non-parturient mare.[1,2] The initial treatment protocol consisted of a 2-wk treatment in which progesterone, estrogen, and a dopamine D2 antagonist (sulpiride or domperidone) was administered daily. Mares were milked within a few days after the start of sulpiride treatment, and in some experiments, milking was continued after the end of treatment. The results of these studies indicate that lactation can be induced in mares that have foaled in previous years, but that the production of colostrum at the onset of lactation is minimal to non-existent. A comparison between sulpiride and domperidone indicated that both products are effective in inducing milk production.

In a subsequent study, we have examined the influence of season on milk production after induction of lactation. These studies were conducted in

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March and September using mares that had cyclic reproductive activity. No difference in mean milk production was detected between mares induced in spring and autumn. Although only a limited number of mares (n = 5/group) were used, we suggest that lactation can be induced in cyclic mares regardless of the time of year. In the same year, we have also examined the relative importance of ovarian steroids in the induction treatment.[3] Intact estrous mares and ovariectomized mares were induced using a dopamine-antagonist only. While intact mares in estrus produced significant amounts of milk after 1 wk of sulpiride treatment, ovariectomized and untreated estrous mares did not produce milk. The results suggest that at least one of the ovarian steroids (progesterone or estrogen) is necessary for the successful induction of lactation in mares that have had at least one foal in previous years.

In 2000, a mare with induced lactation who had produced several foals in previous years adopted a newborn foal. The mare continued to receive sulpiride for about 6 wk after adoption. The mare demonstrated an apparently normal maternal behavior and nursed the foal until weaning age. The growth rate of this foal during the first month and the weight at weaning was similar to six contemporary control foals. This was the first indication to our knowledge that mares with an induced lactation are able to nurse a foal to weaning age.

In 2001, a study was conducted aimed at improving the treatment protocol and testing the hypothesis that mares with an induced lactation are able to adopt a foal, develop a normal maternal behavior, and nurse the foal until weaning age.

2. Experiment 1

Material and Methods

In the first experiment, three induction protocols were compared using 24 non-pregnant, non-parturient Welsh pony mares that had previously delivered and nursed at least one foal in previous years.[4]

Treatment 1 was used in most of the previous experiments and served as the reference treatment. This treatment consisted of 2 wk of treatment. During week 1 (days 1–7), steroids were delivered using a vaginal sponge containing 500 mg altrenogest and 50 mg estradiol benzoate. During week 2 (days 8–14) of the treatment, the first vaginal sponge was replaced by a second identical vaginal sponge that was left in place from day 8 to 14. Estradiol benzoate (50 mg, IM) and prostaglandin (5 mg dinoprost, IM) were administered by intramuscular injection on day 8, and [±]sulpiride (1 mg/kg, IM, q 12 h) was administered on days 8–14. Mares were milked five times per day between 8:00 a.m. and 10:00 p.m. using a milking machine designed for goats, and oxytocin (5 IU, IM) was administered approximately 2 min before milking. Milking was started on day 9.

Note: the vaginal sponges were prepared in our laboratory but have since been replaced successfully by daily administration of altrenogest (Regumate, 44 mg/day, PO) and estradiol-benzoate-in-oil (10 mg/ml peanut oil, 10 mg/day, IM).

Treatment 2 (n = 6) was designed to increase the accumulation of colostrum before the first milking. In treatment 2, the start of milking was postponed until the end of week 2. Mares received the same treatment described in treatment 1 except that prostaglandin was administered on day 13. Milking was started on day 14.

Treatment 3 (n = 6) was designed to offer a shorter alternative to the existing induction protocol. Mares received only the treatment described for week 2 in treatment 1. Mares were milked on day 2 of treatment.

Results

The daily milk production is summarized in Figure 1. No significant differences in daily milk production between treatments were observed. Neither the treatment during week 1 nor the milking during week 2 seems to influence daily milk production.

Thus, it seems that a 1-wk treatment combining progesterone, estrogen, and sulpiride without concurrent milking effectively induces lactation in mares. Milking was continued after the end of hormonal treatment (day 14 in Fig. 1). In all mares, milk production remained relatively constant for at least 1 wk when milking five times per day was continued.

IgG content was measured in milk samples collected during the first 2 days of milking. Of the 51 samples that were analyzed, only 4 had IgG concentrations higher than 7 g/l (8, 17, 43, and 45 g/l). Thus, it seems that accumulation of milk does not increase IgG contents in the first milk that is obtained.

3. Experiment 2

To determine if continued sulpiride administration further increases milk production after the end of the induction protocol, sulpiride treatment was reinitiated on day 23 (week 4) in nine mares randomly selected from the previous experiment (experiment 1). Milk production after 7 days of sulpiride treatment (day 30) was significantly higher compared with four non-treated mares that had been milked for the same length of time. In the non-treated mares, milk production on day 30 had increased about 11% in contrast to 75% in mares treated with sulpiride. These results suggest that continuation of sulpiride treatment beyond day 14 (day 14 as described in experiment 1) might further increase daily milk production.

4. Experiment 3

The aim of this experiment was to combine treatments 2 and 3 in experiment 1 (milk accumulation + short treatment). Six mares received the treat-

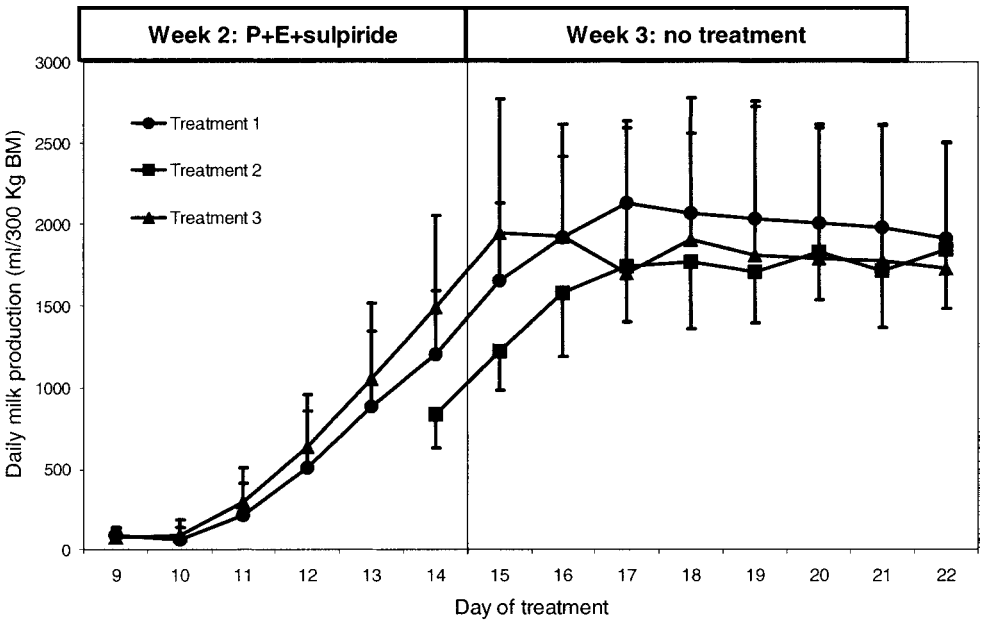

Fig. 1. Daily milk production per 300 kg of body weight.

ment described for week 2 in treatment 1 except that prostaglandin was administered on day 6 of sulpiride treatment and milking was started on day 7 of treatment (designated as treatment 4). Daily milk production on the last day of sulpiride treatment in treatment 4 was similar to production observed in the three treatment groups in Experiment 1.

5. Experiment 4

To determine the growth rate of foals adopted by mares with an induced lactation, 16 newborn foals and three 7-day-old foals were adopted by mares with induced lactation. Mares with induced lactation were selected from the experiments described above. All adopting mares were administered sulpiride on the days before adoption and sulpiride treatment was continued for 3 days after adoption. Fifteen foals were left with their natural mother and used as controls. All foals were weighed on the day of birth, days 14, 30, 60, and 120, and at weaning. Adopted foals had a significant lower daily weight gain during the first 4 wk after adoption, but at weaning age, adopted and control foals had the same body weight (see Fig. 2).

6. Adoption Procedures

Materials and Methods

Adoption was realized using one of two methods.[5] Mares in group 1 (n = 11) were placed in an individual stall and confined behind a padded bar placed horizontally at chest height. A foster foal was removed from its natural mother at birth (n = 6) or at 7 days of age (n = 3) and introduced to the

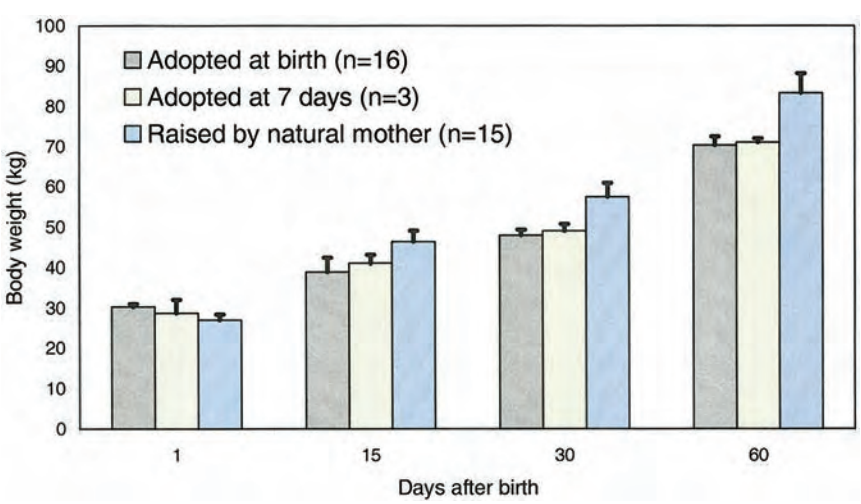

Fig. 2. Weight of foals.

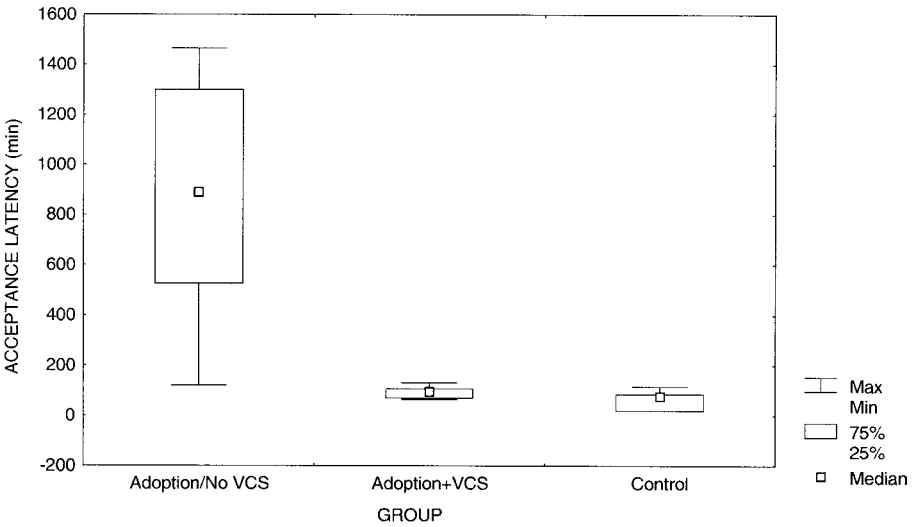

Fig. 3. Median time interval between introduction of the foal and the first successful suckling attempt with no overt aggressive responses from the mare (acceptance latency) for all three conditions.

adoptive mare. The foal was held close to the mare's head while the mare received vaginal-cervical stimulation. The foal remained in the stall with the mare and was observed until the foal was accepted at the udder for the first time. In group 2, mares were treated in the same manner as those in the above group, but did not receive vaginal-cervical stimulation when the foster foal was introduced. Mares were disciplined if they responded aggressively to the foal. Seven mares that initially displayed high levels of aggression toward the foal received a tranquilizer once or twice (acepromazine). Pairs of parturient mares and their newborn foals served as a control group for the observations of maternal behavior. The control mares were not confined behind a bar during the observation period. Two days after introduction of the newborn foster foal, each of the 16 adoptive mothers was tested for her responses to her adopted foal versus an unfamiliar stimulus foal of the same age. In addition, eight control mares were tested with their biological offspring and an alien foal. During the 3-min observation, the mare was free to move about the 8 × 10-m test pen; the two foals were held on the opposite side of one of the 8-m fences, one at each end. Two observers recorded the mare's latency to approach each of the foals, and the length of time that she spent near them.

Results

All 16 non-parturient, lactating mares successfully adopted their foster foal (allowed it to suckle with no signs of aggression). However, there were significant differences in the acceptance latencies across the three conditions (Fig. 3). Acceptance took significantly longer for the non-parturient mares that did not receive vaginal-cervical stimulation than for mares in the vaginal-cervical stimulation condition and the control mares.

In the choice tests, mares in all three conditions spent significantly more time near their "own" foal compared with the unfamiliar stimulus foal. However, there were no significant differences between the number of mares that first approached their own foal versus the number that initially approached the alien foal in any of the conditions.

7. Conclusion

Taken together, the results of the studies described above indicate that lactation can be induced in mares that have foaled in previous years. These mares are able to adopt a foal and nurse it until weaning age. The initial difference in daily growth rate is likely the combined result of the lesser milk production at the onset of an induced lactation versus a post-partum lactation and the abrupt ending of hormonal treatment only 3 days after adoption. Experimental data suggest that the prolonged treatment with sulpiride may help to overcome the initial insufficient milk production.

References

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