The reproductive performance of Thoroughbred mares treated with intravaginal progesterone at the start of the breeding season

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Abstract

The objective of this study was to investigate the effects of intravaginal progesterone on the reproductive performance of transitional Thoroughbred mares on commercial stud farms. Two hundred twenty-seven (227) non-lactating transitional Thoroughbred mares aged between 4 and 18 y (mean 9.4 \pm 3.2 y) located on three stud farms in the Waikato region of New Zealand were used in the study performed during four consecutive breeding seasons (2007–10). Mares were age-matched in pairs and either treated with an intravaginal progesterone releasing device (Cue-Mare, 1.72 g progesterone, 10\% w/w) for up to 10 d (Treated; n = 126) or left untreated (Control; n = 101). In both groups, 1,667 iu of hCG was given IV when an ovarian follicle \geq 35 mm was detected (in conjunction with estrous behavior) and each mare was bred by natural service. Treated mares were served earlier in the breeding season (mean \pm SD interval to first service was 13.9 \pm 3.0 vs 26.7 \pm 13.2 d for Treated and Control groups, respectively; P < 0.001). In the Treated and Control groups, 95.2 and 42.6\% of mares were served within the first 21 d of the season (P < 0.001). Treated mares conceived earlier in the breeding season (mean number of days to conception 37.5 \pm 14.2 vs 50.8 \pm 21.3 d, P = 0.01). There was no difference between groups in the first service pregnancy rates (53.9 and 50.5\% for Treated and Control mares, P = 0.89). Treatment with an intravaginal device increased the number of mares conceiving by the end of the breeding season (91.3 vs 82.3\% for Treated and Control groups, P = 0.04). Therefore, this treatment protocol appeared to offer a convenient, economical and reliable method for managing transitional mares on commercial Thoroughbred stud farms.

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1. Introduction

The mare is seasonally polyestrous with regular ovulatory cycles occurring in response to increasing day length [1]. The Thoroughbred breeding season officially commences on September 1 in the southern hemisphere; since there is a desire to breed mares as early as possible in the season, most non-pregnant mares are still in the transition phase from winter anestrus to normal ovulatory estrous cycles [2]. The transition period lasts between 60 and 80 d and is characterized by erratic estrous behavior and the growth and regression of ovarian follicles which fail to ovulate [1,3].

Several methods have been utilized in an attempt to advance the onset of normal ovulatory estrous cycles in transitional mares. These methods include the use of artificial light exposure commencing several weeks be-
fore the start of the breeding season [3–5] and pharmacologic methods, such as: a) GnRH or its analogues; [6–8] b) oral progestagens; [9,10] c) progesterone administered parenterally; [11] d) eFSH administration; [12,13] and f) dopamine antagonists, such as domperidone or sulpiride [14–16]. The effectiveness of these methods varies considerably, and in addition, all involve at least once daily administration.

The intravaginal route offers a relatively cheap and convenient method of administering progesterone to mares that avoids the need for daily treatment. Intravaginal devices designed for cattle (CIDR, PRID) have been used off-label in mares and are effective in stimulating follicle growth in transitional mares [17–20]. Generally, cattle devices have not gained widespread acceptance because clinically they are associated with discomfort and marked vaginitis [18,21]. We recently reported that treatment of transitional mares with an intravaginal progesterone-containing device specifically designed for mares (Cue-Mare, Bioniche Animal Health Australasia, Victoria, Australia) for 10 d, resulted in follicle growth and ovulation within 4 d of device removal [22], and that the devices were associated with minimal discomfort and vaginitis [23]. Such a treatment therefore offers a potential method of managing the transition period on commercial stud farms.

The aim of this study was to investigate the effects of intravaginal progesterone on the reproductive performance of transitional Thoroughbred mares on commercial stud farms.

2. Materials and methods

2.1. Animals

Two hundred twenty-seven (227) non-lactating Thoroughbred mares between 4 and 18 y of age (mean 9.4 ± 3.2 y) located on three stud farms were used. The study was performed during four consecutive breeding seasons (2007–10). All mares remained outside on pasture (consisting of perennial ryegrass) under natural light for the duration of the study and had ad libitum access to water and hay. The study location was the Waikato region of New Zealand (latitude 37°49′ S). Mares were enrolled for treatment on or before September 6 in each breeding season. The official Thoroughbred breeding season commences on September 1 in the Southern Hemisphere. Approval for the study was granted by the Massey University Animal Ethics Committee.

2.2. Mare selection

On each stud farm, the reproductive tracts of all non-pregnant resident mares were examined by transrectal ultrasonography every second day between August 18 and 31 in each breeding season. Mares with a CL were deemed to be cycling and were excluded from the study. The remaining mares were included in the study if they had no abnormalities of the reproductive tract as determined by palpation and ultrasound examination, had been exhibiting estrous behavior continuously for at least 10 d before treatment, and the diameter of the largest ovarian follicle at any examination during this period was 20 to 25 mm. Selection of mares based on follicle size and estrous behavior was performed to ensure that they were in the transitional phase of the anovulatory period [1]. Treatment commenced between 1st and 6th September in each season. After each examination session mares were age-matched in pairs and assigned randomly to the treatment and control groups by tossing a coin. All mares remained with their original paddock-mates and were managed identically. In 2009, two of the participating stud farms did not allow an equal number of control mares to be left untreated. This increased the number of mares in the treatment group.

2.3. Treatments and examinations

In the Treatment group, each mare was treated with an intravaginal progesterone releasing device (Cue-Mare, Bioniche Animal Health Australasia, Victoria, Australia) for 7 or 10 d. The device consists of two main components: i) the carrier body or “wishbone” which is used to hold the treatments inside the vagina; and ii) two “pods” which are attached to the arms of the wishbone and contain progesterone (1.72 g, 10% w/w) which is formulated into a soft, silicone matrix [23]. All mares were examined by transrectal ultrasonography using a 5 MHz linear-array transducer (Aloka SSD 500V) every second day from Day -10 until day 0 (day 0 = day of device insertion). Mares in the treatment group were examined again on day 7 and the intravaginal device removed if a follicle ≥ 35 mm in diameter was detected. Mares with a follicle < 35 mm on day 7 were re-examined on day 10. Mares in the control group were managed as per the usual routine on the stud farm, i.e., mares were teased every second day and presented for ultrasound examination on a bi-weekly basis.
2.4. Breeding

After device removal in the treatment group, daily ultrasound examinations continued and each mare was exposed to a pony stallion to determine estrous behavior. Human chorionic gonadotrophin (hCG, 1,667 iu; Chorulon, Intervet Australia, Pty Ltd, Victoria, Australia) was administered IV when a follicle ≥ 35 mm was detected in conjunction with estrous behavior. Each mare was served by natural service 24 to 36 h after hCG administration to one of nine Thoroughbred stallions all of proven fertility. Each mare was examined by ultrasonography at 24 h intervals after service to determine the day of ovulation and at 14 to 16 d after service to determine pregnancy status. Pregnancy was confirmed at 28 and 42 d after service.

In control mares, ultrasound examinations were performed biweekly (every 3–4 d) commencing on Day 0. Breeding management and pregnancy diagnosis was identical to the Treatment group. Control mares were served by the same stallions as the Treatment group mares.

Regardless of group allocation, all mares that failed to conceive to their first service were managed the same way for the remainder of the season. This involved repeated teasing, ultrasound examinations and breeding by natural service until the mare conceived, or until the end of the breeding season. On all three stud farms, the breeding season ended on or before December 24.

2.5. Statistical analyses

The specific measures of reproductive performance (dependent variables) of interest were (i) interval from September 1 to first service, (ii) interval from September 1 to conception, (iii) first service pregnancy rate and, (iv) end-of-season pregnancy rate. The end-of-season pregnancy rate was defined as the proportion of mares in each group pregnant at ≥ 42 d of gestation at the end of the breeding season [2]. Multiple logistic regression was used to determine the effects of the independent variables, namely, treatment, mare age, covering stallion, stud farm, and year on the first service and end-of-season pregnancy rates. Multiple linear regression was used to determine the effects of the independent variables; treatment, mare age, covering stallion, stud farm and year on days to first service and days to conception after September 1. The cumulative proportion of mares in each group conceiving after September 1 was calculated using the Kaplan-Meier method of survival analysis. Data are presented as mean ± SD. Analyses were performed using SigmaPlot Version 11.0 (2008, SPSS Software, Inc, Chicago, IL, USA) and R Version 2.9.0 (2009, http://www.r-project.org). Significance was determined at P < 0.05.

3. Results

During the treatment period none of the intravaginal devices was expelled. Thirteen mares (10.3%) had the device removed on Day 7 when a follicle ≥ 35 mm in diameter was detected. The remaining mares (89.7%) had the device removed on Day 10. Reproductive outcomes for mare age, farm and year of the study are shown (Table 1).

3.1. Time to first service and to conception

Mare age, covering stallion, stud farm and year of the study had no significant effects on the time to first service (Table 1). The only independent variable significantly associated with time to first service was treatment group. Mares treated with an intravaginal device were served significantly earlier in the breeding season (mean interval to first service was 13.9 ± 3.0 vs 26.7 ± 13.2 d for treated and control groups, respectively; P < 0.001; Table 2). In the treatment group, 95.2% of mares were served within the first 21 d of the season compared to 42.6% of control mares (P < 0.001; Table 2). Treatment duration reduced the time to first service with mares treated for 7 d being served 2.5 d earlier than mares treated for 10 d (P = 0.002; Table 3).

Mare age, covering stallion, stud farm and year of the study had no significant effects on interval to conception (Table 1). However, mares treated with an intravaginal device conceived earlier in the breeding season (mean number of days to conception 37.5 ± 14.2 d vs 50.8 ± 21.3 d for treated and control groups; P = 0.01; Table 2, Fig. 1).

3.2. First service pregnancy rate

None of the independent variables had a significant effect on the first service pregnancy rate. The first service pregnancy rates were 53.9 and 50.5% for treated and control mares, respectively (P = 0.89).

3.3. End-of-season pregnancy rate

Mare age, covering stallion, stud farm and year of the study had no significant effects on the end of season pregnancy rate (Table 1). However, treatment with an intravaginal device was associated with a higher number of mares conceiving by the end of the breeding season (91.3 vs 82.3% for treated and control groups, respectively; P = 0.04; Table 2).
In both the Northern and Southern hemispheres, the thoroughbred breeding season commences at a time when most non-pregnant mares are in the transition phase from winter anestrus to normal, regular estrus cycles. Early foals are desired because they are generally larger than their later-born peers by the time they are sold at yearling sales at approximately 14 to 17 mo of age [24]. In addition, earlier born foals are more physically advanced than their counterparts when they start racing as 2-y-olds [25]. Consequently, there is considerable pressure on stud managers and veterinarians to ensure that mares conceive as early as possible.

Progesterone and synthetic progestagens are often used to manage the transition period in mares [26]. Delivery is either by daily injection, daily oral administration or from intravaginal devices. The intravaginal route offers a relatively economical and convenient method of administering progesterone to mares that avoids the need for daily treatment and/or injections [17,18,27]. We recently reported that treatment of transitional mares with an intravaginal progesterone-containing device for 10 d resulted in follicle growth and ovulation within 4 d of device removal [22]. Follicle development occurred in close association with rising FSH concentrations during the initial treatment period, with an increase in LH concentrations on Days 6 and 7 supporting continued growth of the dominant follicle. Within 2 d after device removal, mares were in estrus and dominant follicles responded to hCG by induced ovulation.

Treated mares were served significantly earlier in the breeding season compared to untreated control mares. On average, treated mares were served 12.8 d earlier than control mares. Treated mares also conceived 13.3 d earlier than control mares. Breeding mares as early as possible in the season has been shown to have a positive effect on the end of season pregnancy.
rate [28,29], since the earlier in the season a mare commences normal estrous cycles, the more breeding opportunities she has during that season. The duration of the breeding season in New Zealand and Australia is approximately 105 d (3.7 mo), which is significantly shorter than that of the Thoroughbred breeding season in the Northern Hemisphere (approximately 5 mo) [30]. Therefore, it is of even greater importance that in the Southern Hemisphere mares are cycling as early as possible in the season.

The efficacy of progesterone delivered intravaginally in stimulating follicle growth has been reported [17–20,22,27,31], although there have been conflicting reports on the efficacy of progesterone or progestagens in advancing the first ovulation of the year. Some studies detected a positive effect [32], whereas others have not [11,33]. In the present study, the intravaginal device used (Cue-Mare) advanced the first ovulation of the season in treated mares. We previously reported that follicle growth during Cue-Mare treatment was mediated through changes in FSH and LH concentrations during the treatment period [22]. The reported variation in efficacy of progesterone delivered intravaginally is most likely due to the stage of transition during which treatment commenced. In that regard, progesterone and progestagen therapy does not reliably advance the first ovulation of the year when treatment commences in anestrus or early transition [11,17,18,31–35], but in late transition, treatment is more effective [11,17,18,31–35]. In the present study, mares were selected only if they had follicles 20 to 25-mm diameter at the start of treatment, to ensure that the enrolled mares were truly transitional and not in anestrus [1,2]. There was no significant difference between the first service pregnancy rates of treated and control mares. This agrees with the findings of Cuervo-Arango and Clark (2010) [36] who found that transitional mares treated with an intravaginal device designed for cattle (CIDR-B) had similar pregnancy rates to untreated mares served at the first ovulation of the year.

Treatment with intravaginal progesterone significantly increased the number of mares confirmed pregnant by the end of the breeding season. The advancement of the first service date for treated mares effectively extended the breeding season of treated mares compared to control mares by 12.8 d. In the first 21 d of the season, 95.2% of treated mares were served compared to 42.6% of control mares. An improvement in the overall number of mares conceiving obviously has significant economic advantages to mare owners.

Treatment commenced on or before September 6 each year. Given the study design, this meant that mares were not served until September 9 at the earliest. Examining mares and starting treatment even earlier, so that intravaginal devices are removed in the days just before September 1, is likely to produce an even greater improvement in the reproductive performance of treated mares. Further studies are required to confirm this.

Table 3
Reproductive performance of transitional Thoroughbred mares treated with an intravaginal progesterone-releasing device for 7 or 10 d at the start of the breeding season.

<table>
<thead>
<tr>
<th>Duration of treatment (d)</th>
<th>No.</th>
<th>Interval to first service (d)</th>
<th>Interval to conception (d)</th>
<th>First service pregnancy rate (%)</th>
<th>End of season pregnancy rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>13</td>
<td>11.4 ± 2.9</td>
<td>39.2 ± 12.5</td>
<td>53.8</td>
<td>84.6</td>
</tr>
<tr>
<td>10</td>
<td>113</td>
<td>13.9 ± 3.1</td>
<td>37.3 ± 11.9</td>
<td>53.9</td>
<td>92.0</td>
</tr>
</tbody>
</table>

Prob. * 0.002 0.87 1.0 0.37

* P value of dependent variable.

Fig. 1. Kaplan-Meier survival curves for the cumulative proportion of mares conceiving after September 1 for mares either treated with an intravaginal progesterone-releasing device (Treated) or left untreated (Control) at the start of the breeding season.
In conclusion, intravaginal treatment with a progesterone-releasing device was effective in inducing estrus and ovulation in transitional Thoroughbred mares. Compared to control mares, treated mares were served earlier and conceived sooner after the start of the breeding season. By the end of the breeding season, significantly more treated mares were pregnant compared to untreated mares. This treatment protocol appeared to offer a convenient, economical and reliable method for managing transitional mares on commercial stud farms.

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References


