Restricted Conceptus Mobility Results in Failure of Pregnancy Maintenance in Mares[1]

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ABSTRACT

Cycling pony mares were bred and used to test the effect of restricted conceptus mobility on luteal maintenance (i.e. maternal recognition of pregnancy). In Experiment 1, uterine horns were ligated to restrict conceptus mobility to one uterine horn, Group 1; one horn plus the uterine body, Group 2; or one horn, the body and approximately 80% of the second horn, Group 3. Pregnancies were monitored with real-time ultrasonography. Four of five mares in Group 1 and two of four mares in Group 2 returned to estrus (Day 16.0 ± 1.9 and 14.5 ± 0.7, respectively) and subsequently lost the embryonic vesicles (Day 17.2 ± 1.2 and 15.7 ± 0.7, respectively). None of the four mares in Group 3 lost the vesicles. There was a significant effect of the interaction of treatment (amount of uterus available to the conceptus) and day on plasma progesterone (P) concentration (p<0.005).

In Experiment 2, conceptus mobility was restricted to one uterine horn in two groups of mares, of which the second was treated with the synthetic progestin, Regu-Mate (allyl trenbolone). In the first group, each of three mares lost the vesicle (Day 17.3 ± 4.3). In the second group, four of five mares maintained the pregnancies, indicating that pregnancy failure was due to the effects of declining P.

These data indicate that restricted conceptus mobility results in luteolysis in the mare, and that the subsequent decline in P leads to embryonic death. This supports the notion that unrestricted mobility of the equine conceptus, allowing it to interact with most of the uterine endometrium, is necessary for luteal maintenance and conceptus survival.

INTRODUCTION

Maintenance of early pregnancy in the mare requires a functional corpus luteum (CL) for progesterone (P) production and consequent provision of an appropriate uterine environment for conceptus development.

Events leading to luteal maintenance (luteostasis) or luteal regression (luteolysis) must be initiated prior to Day 15 post-ovulation in the mare because CL regression in the nonpregnant mare begins at about Day 15 (ovulation = Day 0) as a result of prostaglandin $F_{2\alpha}$ (PGF) secretion (Hershman and Douglas, 1979; Zavy et al., 1979), PGF is considered to be the natural luteolysin in the mare (Ginther, 1979). Thus, although the phrase "critical period" had been used to define the time during which a conceptus must act to prevent PGF secretion and luteolysis, we prefer the concept that the conceptus must act before a "critical deadline." This concept emphasizes the fact that we incompletely understand the continuum of events leading to luteolysis or luteostasis.

The role of the equine conceptus in maternal recognition of pregnancy has been reviewed recently (Sharp et al., 1984; Sharp and McDowell, 1985; Thatcher et al., 1986). We have suggested that the equine conceptus accomplishes continued luteal function by reducing uterine PGF secretion (Sharp, 1980; Sharp et al., 1984; Zavy et al., 1984a; Sharp and McDowell, 1985). Thus, luteal maintenance in pregnant mares is associated with reduced PGF 1) in the uterine venous drainage (Douglas and Ginther, 1976); 2) in uterine secretions (Berglund et al., 1982; Zavy et al., 1984a), 3) metabolites, 13, 14 dihydro-15-keto-PGFα (PGFM) and 5α, 7α-dihydroxy-11-keto-tetranorprostane-1, 16-dioic acid (11-ketotetranor) in the peripheral circulation (Neely et al., 1979;

Stabenfeldt et al., 1981; Kindahl et al., 1982; Basu, 1984), and 4) reduced concentrations of PGFM in the uterine secretions (Sharp et al., 1984) compared with those of nonpregnant mares. Furthermore, CL of pregnant mares are capable of binding PGF (Vernon et al., 1979) and regressing in response to administration of exogenous PGF (Kooistra and Ginther, 1976).

The mechanism(s) by which the conceptus attenuates PGF secretion by the uterus is not completely understood. However, we have shown that coincubation of equine conceptus membranes with endometrial explants significantly reduces PGF and PGFM production in vitro (Berglund et al., 1982; Sharp et al., 1984; Sharp and McDowell, 1985; McDowell, 1986). Importantly, endometrial explants from pregnant mares, in the absence of the conceptus, produced at least as much PGF as endometrial explants from diestrous mares (Vernon et al., 1981; Berglund et al., 1982). This suggests that the inhibitory effect of the conceptus on endometrial PGF production is transient. Therefore, it is reasonable to assume that the PGF-inhibiting effect of the conceptus on any given portion of endometrium is temporary, and that the conceptus must interact repeatedly or continuously with the entire endometrium to suppress PGF production, perhaps by virtue of its extensive transuterine mobility.

Because uterine PGF most probably reaches the CL by a systemic route in the mare (Ginther and First, 1971; Ginther, 1981), the conceptus must be capable of interacting with the endometrial surface of both uterine horns and the body to effect luteostasis. Ginther (1983a) demonstrated that the equine conceptus is mobile within the uterine lumen, traversing both horns several times daily from the time it can be detected by ultrasonic echography (Day 9 or 10) until Days 16–17. We reasoned that this mobility allows the interaction between conceptus and endometrium that is essential for both luteostasis and growth of conceptus (McDowell et al., 1985). Further, we hypothesized that the mobility is functionally analogous to blastocysts elongation at the time of maternal recognition of pregnancy, which maximizes the area of conceptus-endometrial interaction in the cow, ewe, and sow (McDowell et al., 1985).

The purpose of this study was to test the effect of artificially restricting the mobility of the equine conceptus on the maintenance of the CL.

MATERIALS AND METHODS

Animals

Thirty-seven cycling pony mares were teased by a stallion and palpated daily to detect estrous behavior and time of ovulation (Day 0). The mares were bred either naturally or by artificial insemination. Mares were randomly assigned to the experiment to equalize the number of mares pregnant on Day 9 or 10 post ovulation.

Surgical Procedures

Surgery was performed under general anesthesia on Day 3 or 4, before the conceptus enters the uterus. Mares were tranquilized with acepromazine maleate (4 mg/45 kg; Fort Dodge Lab, Inc., Fort Dodge, IA); anesthesia was induced with thiamylal sodium (Biotal, 1 g; Boehringer Ingelheim, St. Joseph, MO) and maintained with a mixture of halothane (Fluothane, Fort Dodge Lab, Inc.) and oxygen. The uterus was exposed via a flank incision, and double constricting ligatures of synthetic suture (No. 3 Braunamid; B; Braun Melsungen AG, Vescor, Orlando, FL) were placed around one uterine horn. Major blood and lymph vessels were excluded from the ligatures by taking care to pass the suture proximal to the uterine serosa to avoid compromising blood and lymph circulation.

Experimental Design

Experiment 1. Twenty-two mares were assigned to Experiment 1 and divided among three groups in which conceptus mobility was restricted to a) one uterine horn, b) one uterine horn plus the uterine body, or c) one uterine horn, the uterine body and approximately 80% of the contralateral horn. This was accomplished by placing the restricting ligatures a) at the base of the uterine horn ipsilateral to the ovary with the CL (Group 1; n = 9), b) at the base of the uterine horn contralateral to the ovary with the CL (Group 2; n = 5), or c) contralateral to the ovary with the CL, just below the uterotubal junction (Group 3; n = 8).

Blood samples were collected daily by jugular venipuncture until equine chorionic gonadotropin (eCG) (MIP-Test, Diamond Laboratories, Des Moines, IA) was detected, or until 5 days after ovulation

during a subsequent estrus. Beginning on Day 9 or 10, mares were examined every other day by realtime ultrasonography (Equiscan II, 5 MHz probe; Bion Corporation, Denver, CO) to monitor the presence of the conceptus.

Experiment 2. In Experiment 2, 15 mares were prepared as those in Group 1 in Experiment 1 and then assigned to two groups. Animals in Group 1 (n = 8) received no further treatment, and those in Group 2 (n = 7) were treated with the synthetic progestin, Regu-Mate (allyl trenbolone, 2.2 mg/45 kg daily in oil, administered orally; American Hoechst Corp., Somerville, NJ), beginning on Day 8 or 9 to replace endogenous progesterone in mares in which CL regression occurred.

Progesterone Radioimmunoassay (RIA)

Concentrations P in heparinized plasma samples were determined by using a specific antiserum (donated by Drs. Juan Troconiz and Megalay de Manzo, Universidad Central de Venezuela, Facultad de Ciencias Veterinarias, Instituto de Reproducion Animal e Inseminacion Artificial, Maracay, Venezuela) generated in sheep immunized against P conjugated to bovine serum albumin (BSA) at the C^{11}-position. Tritiated P ([1, 2^3H(N)-]P, specific activity 58 Ci/mmol) was purchased from New England Nuclear, Boston, MA. Cross-reactivity of the P antiserum (50% binding) was <1% with 17α-hydroxy-P, 20α-hydroxy-P, 20β-hydroxy-P, cortisol, testosterone, androstenedione, and estradiol-17β (Knickerbocker, 1985); <2% with 3β-hydroxy-5α-pregnan-20-one, 3α-hydroxy-5α-pregnan-20-one and 3α-hycroxy-5β-pregnan-20-one; and <0.2% with 20 α-hydroxy-5α-pregnan-20-one. Standard curves were prepared by adding known amounts of radionert P to phosphate-buffered saline (0.1 M, pH 7.4) containing 1 g/l of Knox gelatin (PBSg) to give P concentrations of 0, 15.6, 31.2, 62.4, 125, 250, 500, and 1000 pg/100 μl PBSg. With an antiserum dilution of 1:45,000, sensitivity (±2 SD; Ekins and Newman, 1970) of the assay was 15.6 pg. Progesterone was extracted from plasma by vortexing for 1 min (Multi-Tube Vortexer, model 2600; Scientific Manufacturing Industries, American Scientific Products, McGraw Park, IL) with 2 ml freshly distilled benzene and hexane (1:2) (Fisher Scientific,

Orlando, FL) and placed in an ethanol/dry-ice bath until the extracted serum was frozen (less than 1 min). The solvent containing P was then decanted, dried under N_2 gas in a 37°C water bath and brought to 500 μl assay volume by the addition of PBSg. Separation of bound and free P was accomplished by addition of dextran-coated charcoal followed by centrifugation.

The intra- and interassay coefficients of variation (CV) for 16 assays were 8.5 and 17.9%, respectively, using duplicate estimates (100 μl) of a 5 ng/ml (4.98 ± 0.89 ng/ml) reference plasma sample, and 6.2 and 12.6%, respectively, using duplicate estimates (100 μl) of a 10 ng/ml (9.4 ± 1.19 ng/ml) reference plasma sample. When a plasma sample containing approximately 10 ng/ml of immunoreactive P was divided into triplicate volumes of 50-, 100-, and 200-μl aliquots, a quantitative linear recovery was achieved (y = −39.368 + 5.759x; y = concentration of P [pg/100 μl] and x = plasma volume extracted [μl]. No significant differences were found between concentrations of P (ng/100 μl) measured using 50-, 100-, or 200-μl samples (p>0.8318). The relationship between concentration of P added and concentration of P measured was linear (y = −0.1422 + 1.0657x; y = concentration of P measured [ng/ml] and x = concentration of P added[ng/ml]) in plasma samples from an ovariectomized mare to which exogenous P was added at doses of 0, 0.5, 1.0, 2.5, 5, and 10 ng/ml. All doses were replicated three times. Regu-Mate did not cross-react with P in the RIA, as demonstrated by the fact that concentrations of P were not different (less than 1 mg/ml) in plasma obtained from 2 ovariectomized mares before and after 30 days of Regu-Mate treatment.

Statistical Analyses

Chi-square analyses (McClave and Dietrich, 1979) were performed to test for independence between treatment and the number of mares that maintained pregnancy in each experiment. Least squares analyses of variance were conducted by the General Linear Models Procedures of the Statistical Analysis System (Barr et al., 1979). The experimental design was a split plot, in which mares were nested within the treatment by status interaction. Mares were sampled

repeatedly over time; therefore, day was considered as a continuous independent variable. Concentrations were characterized by day trends, which were analyzed by polynomial regression. Tests for homogeneity of regression were used to detect differences in day trends for P responses between treatment groups.

RESULTS

Only those mares in which a conceptus was detected with ultrasonography by Day 11 post-ovulation were included in the experiments. Overall, pregnancies were detected in 21 of 37 mares (56.8%). Although conceptus mobility was not quantified, it was determined that the conceptus was moving throughout its available uterine space in all mares.

Experiment 1

Conceptuses were detected with ultrasonography in 13 of 22 mares (60%; 5 of 9, 4 of 5 and 4 of 8, in Groups 1, 2, and 3, respectively; Table 1). Of the 5 pregnant mares in Group 1, 4 returned to estrus on Day 16.0 ± 1.9 (mean ± SEM), and the conceptuses were no longer detectable by ultrasonography by Day 17 ± 1.2. In Group 2, 2 mares returned to estrus on Day 14.5 ± 0.7, and their conceptuses were no longer detectable by ultrasound on Day 15 ± 0.7. Each mare in which the conceptus was lost returned to estrus before the conceptus disappeared. In Group 3, no mares lost their conceptuses or returned to estrus. The number of mares maintaining pregnancy was affected by treatment ($p<0.05$), indicating that the

distribution of mares by status (pregnancy lost vs. pregnancy maintained) was due to the effects of treatment. Positive eCG reactions were observed between 39 and 45 days in all mares that maintained pregnancies.

There were effects of treatment ($p<0.07$), day ($p<0.0001$), and the interaction of status (pregnancy lost vs. pregnancy maintained) and day ($p<0.07$) for peripheral P concentrations. Effects of day on P concentrations for each treatment by status group are shown in Figure 1. P concentrations declined on Days 13–15 in mares that failed to maintain pregnancy, and then increased again with the onset of the next luteal phase. P remained elevated in mares that maintained pregnancies. Tests for homogeneity of regression indicated that the interactions of status by day ($p<0.005$) and treatment by day ($p<0.005$) resulted in patterns of P that were not parallel, indicating that both status (pregnancies lost vs. pregnancies maintained) and treatment (amount of uterus available to the conceptus) had significant effects on P patterns. For mares that maintained pregnancy, changes in P reflecting the interaction of treatment and day were not parallel among the three treatment groups ($p<0.005$). This indicated that treatment affected P concentrations even in groups of mares that maintained pregnancy (Fig. 1, right-hand panels).

Experiment 2

Conceptuses were detected in 8 of 15 mares (53%; 3 of 8 and 5 of 7 in Groups 1 and 2 (Regu-Mate),

TABLE 1. Conceptus survival following ligation of the uterus and restriction of conceptus mobility.

	Conceptuses detected	Conceptuses lost	Days from ovulation (mean ± SEM)	
			To estrus*	To coneptus loss
Experiment 1				
Group 1 (IB)[a]	5	4/5 (80%)	16.0 ± 0.9	17.0 ± 1.2
Group 2 (CB)[b]	4	2/4 (50%)	14.5 ± 0.7	15.0 ± 0.7
Group 3 (CCT)[c]	4	0/4 (0%)	- - -	- - -
Experiment 2				
Group 1 (IB)	3	3/3 (100%)	14.5 ± 3.4**	17.3 ± 4.3
Group 2 (IB + Regu-Mate)[d]	5	1/5 (20%)	32.0	16.0

[a]IB = Ligated at the base of the ipsilateral horn.

[b]CB = Ligated at the base of the contralateral horn.

[c]CCT = Ligated at the cranial tip of contalateral horn.

[d]IB + Regu-Mate = Ligated at the base of the ipsilateral horn and treated with the synthetic progestin, Regu-Mate.

*Excluding mares that remained pregnant.

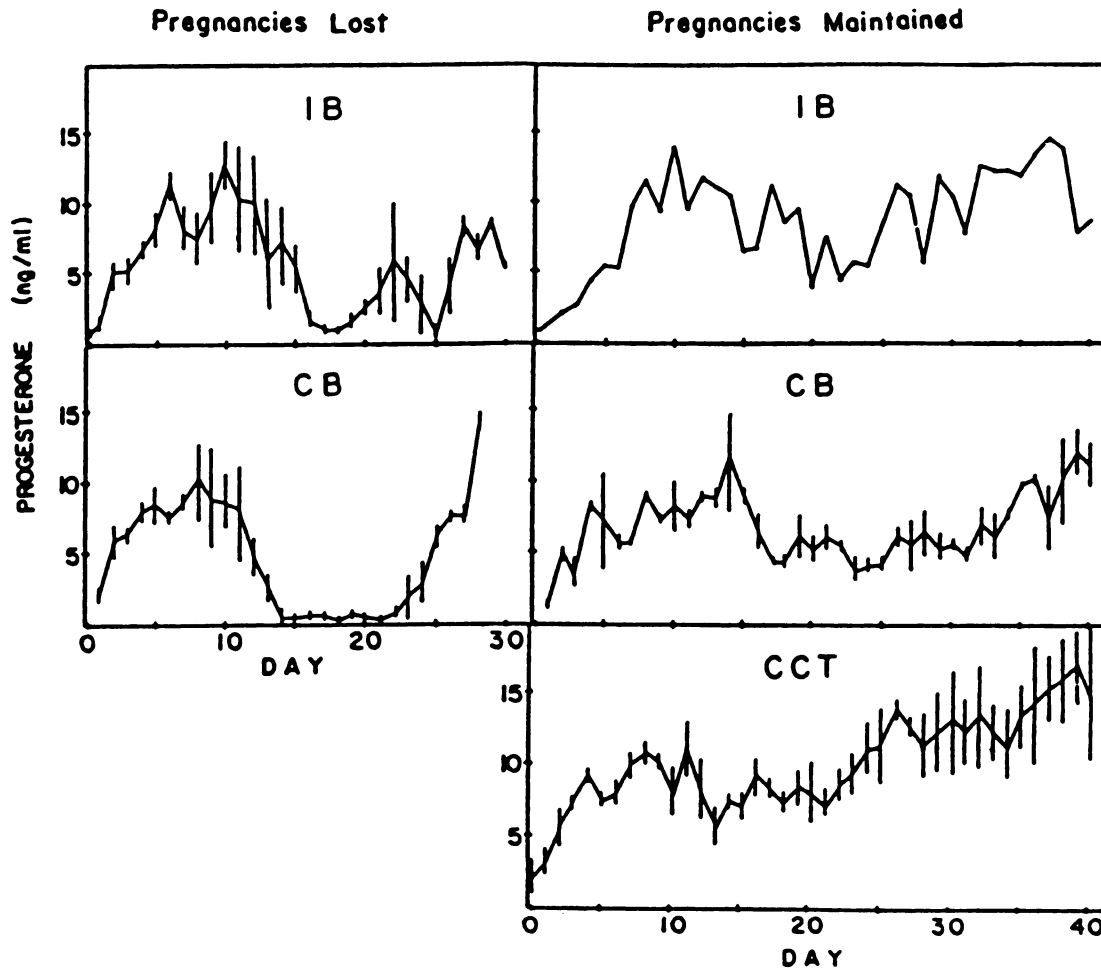**n = 2, the third mare apparently became anestrous (see text).

EXPERIMENT I

FIG. 1. Preipheral plasma progesterone concentrations (mean ± SEM), Experiment 1. Ligature placement was at the base of the uterine horn, either ipsilateral to the side of ovulation (*IB*; Group 1; n = 5), or contralateral to the side of ovulation (*CB*; Group 2; n = 4), or at the cranial tip of the uterine horn contralateral to the side of ovulation (*CCT*; Group 3: n = 4). The time scale refers to day after ovulation (Day 0).

respectively, Table 1). In Group 1, all 3 mares lost their conceptuses. Two of the three mares returned to estrus on Day 14.5 ± 3.4, prior to loss of the conceptus (Day 17.3 ± 4.3); the third mare did not return to estrus and presumably became anestrous (Table 2). In Group 2 (Regu-Mate), one of the mares lost her conceptus on Day 16 and returned to estrus on Day 32, 2 days after Regu-Mate was discontinued. As in Experiment 2, the number of mares maintaining pregnancy was affected by treatment ($p < 0.005$).

There were effects of day ($p < 0.0001$) for peripheral plasma P concentration. P concentrations for each treatment and status group are shown in Figure 2

TABLE 2. Size of conceptus vesicle at last measurement prior to loss (Experiment 1).

Mare number	Group*	Day of loss	Diameter of vesicle[a] (mm)
133	1	18	22.0
462	1	15	26.0
435	1	19	24.5
464	1	16	24.5
480	2	16	22.5
481	2	14	21.5

[a]For comparison, vesicle diameter in Group 3 (no conceptus loss) was 23.4 ± 1.6 mm on Day 16.

*Group 1 = ligature placed ipsilateral to ovulation. Group 2 = ligature contralateral to ovulation.

EXPERIMENT 2

Pregnancies Lost   Pregnancies Maintained

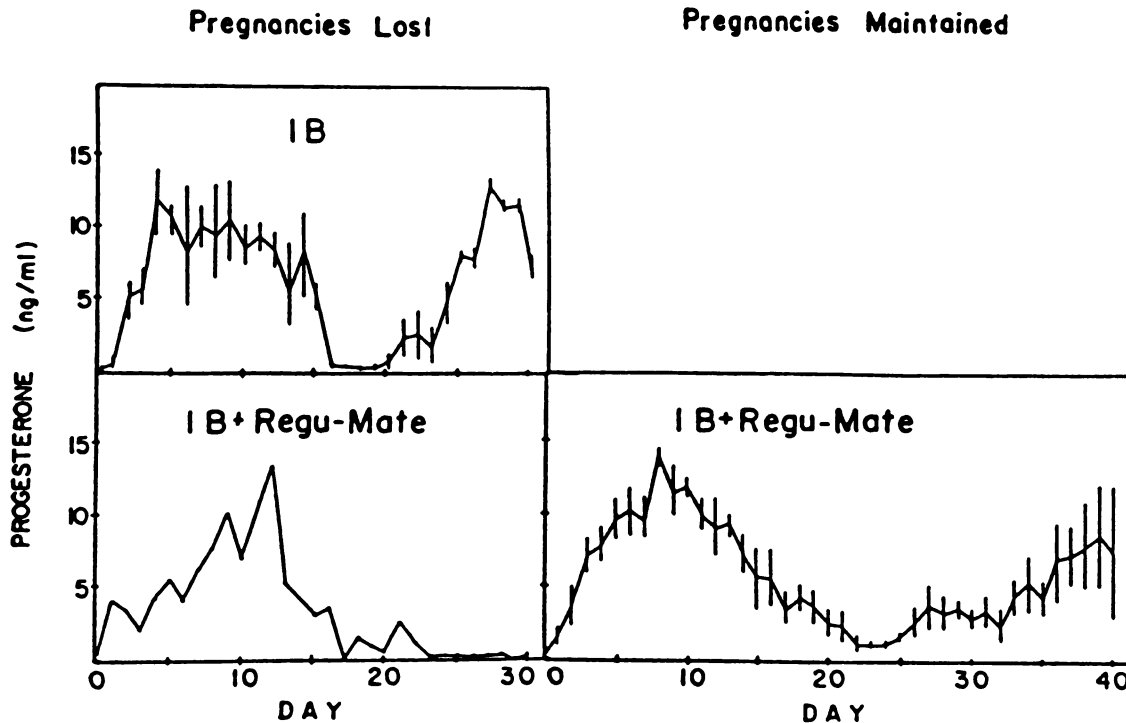FIG. 2. Peripheral plasma progesterone concentrations (mean ± SEM), Experiment 2. Ligatures were placed at the base of the uterine horn ipsilateral to the side of ovulation (*IB*; Group 1; n = 3). Mares in Group 2 (*IB* + *Regu-Mate*; n = 5) were supplemented with the synthetic progestin, Regu-Mate. The time scale refers to day after ovulation (Day 0).

(mean ± SEM). Tests for homogeneity of regression indicated that P responses for days were not parallel among groups ($p<0.005$). P concentrations fell in all mares in Group 1 (Fig. 1). Concentrations of P remained low in one mare in which pregnancy was lost on Day 16, despite treatment with Regu-Mate (Fig. 2; IB + Regu-Mate, pregnancy lost). P also decreased in Group 2 (Regu-Mate-treated) mares that maintained their pregnancies (Fig. 2; IB + Regu-Mate). However, P appeared to decline more slowly than in mares that lost their pregnancies and began to increase again prior to the time at which secondary CL would be expected to contribute to circulating P levels. In this group, each mare had concentrations of P of less than 1 ng/ml for periods of 2–5 days (data for individual mares not shown).

DISCUSSION

These data support the concept that mobility of the conceptus is essential to pregnancy maintenance in mares. Luteostasis failed (as indicated by a decline in peripheral plasma P and return to estrus prior to

conceptus loss) in 7 of 8 of the mares (87.5%; Experiments 1 and 2 combined) in which conceptus mobility was restricted to one uterine horn and 2 of the 4 mares in which conceptus mobility was restricted to one uterine horn plus the uterine body (50%). However, all 4 mares remained pregnant when the conceptus was allowed access to almost the entire uterine lumen (Table 1). The amount of uterus occupied or, conversely, unoccupied, is, therefore, related to the proportion of pregnancies maintained in each group. Similar findings have been reported for pigs, when a similar ligation technique was used to restrict the amount of uterus occupied by the conceptuses (Dhindsa and Dziuk, 1968). That mares in Experiment 2, Group 2, maintained pregnancy indicates that as long as a source of progestin was available to stimulate uterine secretions, pregnancy was maintained, and that the limited uterine space available was adequate to provide nutrients for conceptus survival, at least during this early stage.

Although not studied critically, there appeared to be no difference between groups in size of the embryonic vesicle as detected with ultrasound. Further-

more, there was little indication of impending loss of a given conceptus until it disappeared. In Experiment 1, Group 1, for instance, the diameter of the vesicle the day prior to vesicle loss was 24.2 ± 1.2 mm (day of loss 17.0 ± 1.2) compared with the diameter of vesicles of conceptuses in Experiment 1, Group 3, at a comparable time (23.4 ± 1.6 mm; Day 16; see Table 2). In Group 1, in which the conceptus had no access to the cervix, fluid, unbound by a membrane, was commonly observed within the uterine horn at the time of loss. One gained the impression with ultrasonic observation, that the embryonic membranes had ruptured, releasing the yolk sac fluid into the uterine lumen. In Groups 2 and 3, in which the conceptus had access to the cervix, fluid was seldom observed within the uterine lumen when a discrete vesicle was no longer observed with ultrasound. In recent experiments (D. C. Sharp, unpublished observations, 1987) in which embryo loss was induced via PGF administration and uteri were flushed upon failure of ultrasonic detection of a discrete vesicle, or fluid within a uterine horn, conceptus membranes were still recovered in a high percentage of mares. It is unknown whether the conceptus membranes are eventually resorbed (Ball and Woods, 1987) or whether they pass through the cervix. Certainly, in the case of conceptus loss in Group 1, the latter option was not available.

Although mobility of conceptuses within their confined uterine space was not monitored critically, it was noted that they did migrate within the space to which they were confined, but were never observed in the remaining uterine space, indicating that the ligatures remained intact. Furthermore, in subsequent experiments, the ligatures were examined visually at surgery and were removed. They were intact in all cases.

The amount of occupied uterus affected not only the proportion of mares maintaining pregnancy in each treatment group (Table 1), but also patterns of circulating P (Experiment 1; Fig. 1). The slow decline in P concentrations in Group 2 (Experiment 2; + Regu-Mate) mares, and its subsequent increase prior to Day 40, indicated that rapid and complete luteal regression may not have occurred in those mares. Moor et al. (1970) demonstrated that luteolysis could be reversed in sheep by hysterectomy on Day 15, even after P had begun to decline and morphological changes in the CL had begun. When PGF was infused into the uterine vein, some ewes underwent partial luteolysis, that is, a decrease and subsequent

increase in P (Thorburn and Nicol, 1971). In addition, declining concentrations of P may be necessary to ensure rapid and complete CL regression (Thorburn et al., 1973; Baird et al., 1976; Baird and Scaramuzzi, 1976; Smith et al., 1979; McCracken et al., 1984). If a decrease in P concentrations is necessary for rapid and complete luteal regression in the mare, the administration of Regu-Mate may have interfered with the luteolytic process.

The hypothesis that the conceptus accomplishes luteal maintenance, at least in part, by reducing or suppressing uterine production of luteolytic amounts of PGF has also been proposed for the ewe (McCracken et al., 1984), cow (Thatcher et al., 1984) pig (Guthrie and Rexroad, 1981), and guinea pig (Poyser, 1984). It has also been proposed that the pig conceptus brings about luteal maintenance by redirecting PGF secretion from the uterine vasculature toward the uterine lumen (Bazar and Thatcher, 1977).

Transuterine migration of conceptuses is common in pigs (Dziuk, 1977) and sheep, but rarely occurs in cows (McLaren, 1982). In pigs, the conceptuses do not migrate prior to Day 9 and cease to migrate by Day 13 (Polge and Dziuk, 1970). The migration and equidistant spacing of pig conceptuses appear to be necessary for maintenance of pregnancy (Polge and Dziuk, 1970; Dziuk, 1985).

The equine conceptus moves from one uterine horn to the other as many as 13 times per day (Ginther, 1984). It is mobile from the time it can first be detected by ultrasonography (Day 9—11) until Day 16 or 17, (Ginther, 1983b). The intrauterine mobility of the equine conceptus is progressive (Ginther, 1983a,b) and appears to be caused by coordinated muscular activity of the uterus (Leith and Ginther, 1985). Indeed, small fluid-filled balloons are moved in a similar fashion but less rapidly (Ginther, 1985b). It is probable that mobility begins in the oviduct, where developing blastocysts may bypass unfertilized ova or fertilized ova that fail to develop, the former moving into the uterus 5—6 days after ovulation, and the latter being retained in the oviduct and degenerating (van Niekerk and Gerneke, 1966; Betteridge and Mitchell, 1974, 1975; Betteridge et al., 1979). Blastocyst transport from the oviduct into the uterus is independent of the ipsilateral CL, since blastocysts transferred to the oviduct contralateral to the CL may also establish a normal pregnancy (Betteridge et al., 1979; Peyrot et al., 1987). Ball and Woods (1987) reviewed the incidence of early embryo loss in mares and demonstrated that up to 26% of embryo losses

occurred by Day 20. This suggests that the time of extensive embryo migration throughout the uterus and the necessity for inhibiting PGF secretion are temporally related to the time of maximal embryo loss. Although the proportion of embryo loss due to insufficient embryo migration, and thus inadequate PGF blockade, is not known, it probably contributes to the high incidence of embryo loss at this time.

During the time of extensive conceptus mobility (Days 10–16), the conceptus is actively synthesizing and secreting a variety of proteins (Fazleabas and McDowell, 1983; McDowell, 1986) and steroids (Heap et al., 1982; Zavy et al., 1984b), and PGF production by the endometrium is attenuated (Berglund et al., 1982; Sharp et al., 1984; Zavy et al., 1984a). This also is a time of high embryonic mortality in the mare. In one report of a 27.4% incidence of embryonic loss between 11 and 40 days, 19% occurred between 11 and 15 days (Ginther, 1985a). Although it is not known how often lack of conceptus mobility results in embryonic mortality, it is probably a contributing factor.

Extensive mobility of the equine conceptus allows it to interact with most of the uterine endometrium. This study establishes that this interaction is necessary for appropriate maternal recognition of pregnancy and resultant luteal maintenance, but the conceptus factor(s) that alter uterine production of PGF are not known. Conceptus mobility may also be critical in allowing a spherical conceptus to maximize access to histotrophe that is essential for its continued development, although this was not addressed specifically in these experiments. Thus, the mobility of the spherical equine conceptus may serve a function similar to the elongation of sheep, cow, and sow blastocysts by establishing maximal interaction and communication between the conceptus and the endometrium during early pregnancy.

ACKNOWLEDGMENTS

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