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Ovarian and placental production of progesterone and oestradiol during pregnancy in reindeer

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Abstract

We obtained uterine and peripheral venous plasma, and samples of luteal and placental tissues from 2- to 7-year-old, Eurasian mountain reindeer (*Rangifer tarandus tarandus*) from a free-living, semi-domesticated herd in northern Norway in November 1995, and February and March 1996. In November, ovarian venous blood was also collected from four animals. Plasma samples were assayed for progesterone and oestradiol. The tissue samples were examined by light and electron microscopy, steroid dehydrogenase histochemistry, and northern blot analysis for RNAs for 3 β -hydroxy-steroid dehydrogenase (3 β -HSD) and P450 (side chain cleavage (scc)). Peripheral blood was taken from non-pregnant females in the same herd on the same dates. Peripheral progesterone concentrations in pregnant reindeer (3.4 ± 0.5 ng/ml, $n = 8$) clearly exceeded those in non-pregnant animals (0.40 ± 0.14 ng/ml; $P < 0.0004$, $n = 10$) but oestradiol levels were only marginally higher in pregnant (6.0 ± 0.7 pg/ml) than in non-pregnant (4.8 ± 0.5 pg/ml; $P = 0.35$) reindeer at the stages examined. In pregnant animals, peripheral progesterone and oestradiol concentrations rose slightly between November and March but the differences did not reach significance (progesterone, $P = 0.083$; oestradiol, $P = 0.061$). In November, progesterone concentrations in the ovarian vein (79 ± 15 ng/ml) greatly exceeded ($P < 0.03$) those in the uterine vein (10 ± 4 ng/ml) which in turn exceeded the levels in the peripheral blood (2.8 ± 0.4 ng/ml; $P < 0.29$). Oestradiol concentrations were slightly but significantly ($P < 0.05$) higher in the ovarian (20 ± 3 pg/ml) than the uterine vein (13 ± 1 pg/ml) and, in turn, greater ($P < 0.03$) than in peripheral blood (4.6 ± 0.4 pg/ml). All samples of luteal tissue consisted exclusively of normal fully-differentiated cells and stained intensely for 3 β -HSD. Isolated groups of placental cells also stained strongly for 3 β -HSD. RNA for P450 (scc) and 3 β -HSD was abundant in all corpora lutea and lower concentrations of P450

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(*scc*) were present in the placenta. 3β -HSD RNA in the placenta was below the limit of detection. We conclude that the corpus luteum remains an important source of progesterone throughout pregnancy in reindeer but that the placenta is also steroidogenic.

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Keywords: Reindeer; *Rangifer*; Pregnancy; Progesterone; Placenta; Ovary

1. Introduction

In the Bovidae, there are important species differences in the relative importance of the ovaries and the placenta in the maintenance of pregnancy. In goats, removal of the corpus luteum causes abortion at any stage of gestation (Sheldrick et al., 1980); on the other hand in sheep and cattle, though the corpus luteum secretes progesterone until term, it can be removed in later gestation without causing abortion because placental progesterone production is sufficient (Casida and Warwick, 1945). In muskoxen (*Ovibos moschatus*; Rowell et al., 1993), Grant's gazelle (*Gazella granti*; Spinage, 1986) and Thompson's gazelle (*Gazella thompsonii*; Hvidberg-Hansen, 1970), the corpus luteum regresses completely during early gestation and it appears that pregnancy is maintained by the placenta alone.

There are also species differences in the Cervidae, but in general, in this family, there seems to be more reliance on the corpus luteum for maintenance of pregnancy, than in the Bovidae. In pregnant white-tailed deer (*Odocoileus virginianus*), peripheral progesterone concentrations barely exceed those of the luteal phase if they exceed them at all (Plotka et al., 1977, 1980) and ovariectomy in the latter half of gestation causes a rapid decline in circulating progesterone and abortion (Plotka et al., 1982). Nonetheless, there is evidence of some placental progesterone production in white-tailed deer (Plotka et al., 1982) and luteolytic doses of prostaglandin $F_{2\alpha}$ do not invariably cause abortion, though they normally do so (Becker and Katz, 1992; DeNicola et al., 1997). Likewise in red deer (*Cervus elaphus*), the peripheral progesterone concentrations of pregnancy are similar to those of the luteal phase (Kelly et al., 1982; Adam et al., 1985; Barrell and Bos, 1989) and ovariectomy, at least in early gestation, causes abortion (Asher et al., 1996). Further, prostaglandins, or their analogues, have been shown to cause abortion in early pregnancy in red deer (Asher et al., 1996), and in late pregnancy in the closely related wapiti (*Cervus canadensis*; Bates et al., 1982). In reindeer (*Rangifer tarandus*), cloprostenol given in the middle third of pregnancy caused an immediate and marked reduction in peripheral progesterone concentration: pregnancy was terminated in all four reindeer treated in early December, and in one of two animals treated in mid-January; the remaining animal was carrying a normal fetus at slaughter in February (Ropstad et al., 1996).

Progesterone concentrations are about twice the maximum luteal phase values by the end of the 3rd month of pregnancy in fallow deer (*Dama dama*; Willard et al., 1998) suggesting a placental source of progesterone and there is evidence that the placenta produces progesterone in roe deer (*Capreolus capreolus*). In this species, the ovaries contain active corpora lutea (Short and Hay, 1966), and blood progesterone concentrations are elevated (Shams

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