Uterine and Ovarian Blood Flow in a Holstein Friesian Cow with Aplasia of One Uterine Horn

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ABSTRACT. The ovarian dynamics and uterine and ovarian blood flows of a 6-year-old (2 parturitions) Holstein Friesian cow with right uterine horn aplasia were observed during two estrous cycles. In one estrous cycle, a corpus luteum (CL) formed in the right ovary, but regression of the CL and subsequent ovulation were not observed. In the other estrous cycle, a CL formed in the left ovary and delayed regression of the CL and subsequent ovulation were observed. The blood velocity of the right uterine artery was lower than that of the left uterine artery throughout both estrous cycles when a CL formed in either the right or left ovary. The blood velocities of the right and left ovarian arteries were unaffected by right uterine horn aplasia and changed depending on the presence of a CL. These results indicated that the blood flow of the right uterine artery was very weak and that aplasia of one uterine horn affects the estrous cycle, especially CL regression.

KEY WORDS: aplasia of uterine horn, blood flow, cattle.

Cows often show congenital genital anomalies, including intersex disorder (hermaphrodisim, freemartin) and paraneoplastic uterine tubal aplasia (tubal aplasia, white heifer disease, external uterine orifice duplex) [1, 5, 7, 9, 10]. White heifer disease is an aplasia of the Müllerian ducts in conjunction with the white fur gene that results in aplasia of the uterus, uterine cervix, and vagina. The ovaries, uterine tubes, and vulva develop normally, but the hymen is sometimes persistent. After puberty, cows have normal estrous cycles, and may be capable of becoming pregnant if only one uterine horn is affected [1].

Uterine blood flow in cows show an estrous cycle dependent pattern [3]. It is speculated that the rhythmic changes in blood flow are regulated by the estradiol-17β (E2) and progesterone (P4) concentrations. Fluctuations in the E2 and P4 concentrations also affect the regulation of ovarian blood flow [11]. Additionally, it has been reported that there were significant differences in ovarian blood flow between the ipsilateral and contralateral ovaries when a CL was present in single ovariatory animals [4]. The aim of this study was to investigate the ovarian dynamics and uterine and ovarian blood flow of a cow with suspected white heifer disease.

A six-year-old Holstein Friesian cow with no abnormalities detected except right uterine horn aplasia was used for this study. The cow’s uterine condition was examined by rectal palpation and transrectal ultrasonography, and whole right uterine horn aplasia was confirmed. The cow had undergone two normal gestational periods and parturitions, and the first day of observation was 244 days postpartum. Observation of the ovaries and uterine and ovarian blood flow was performed by the same individual once daily throughout estrous cycles when a CL was present in either the right or left ovary (a CL was present in the right ovary in the first estrous cycle and the left ovary in the second estrous cycle). The ovarian structures were observed using a B-mode ultrasound scanner (Pro Sound SSD-4000, Aloka Co., Ltd., Tokyo, Japan) equipped with 7.5 MHz transrectal linear array transducer (UST-995, Aloka Co., Ltd.). The sizes and locations of follicles (>5 mm in diameter) and the corpus luteum (CL >10 mm in diameter) in each ovary were recorded. The day of ovulation (Day 0) was defined as the day on which disappearance of the ovulatory follicle (OF) was confirmed by ultrasonography; disappearance was initially observed on the previous day. Uterine and ovarian arterial blood flow were investigated for both the right and left sides. The uterine artery was examined as described previously [3]. The uterine artery is found within the mesometrium as a movable arterial vessel (Fig. 1). Near its origin from the umbilical artery, the uterine artery can be visualized using the transrectal color Doppler technique. The ovarian artery appears as a conglomerate adjacent to the ovary. This conglomerate can be followed proximally close to its origin from the aorta (Fig. 1). It was at this position that the blood flows were observed by pulsed Doppler ultrasonography. All blood flow velocity waveforms were obtained at an interrogation angle between the Doppler sound beam and blood flow of 30 to 60 degrees. At least two similar consecutive flow velocity waveforms with the maximum end-diastolic frequency shift were used to calculate the blood flows. The resistance index (RI) and mean velocity (MnV) were measured to reflect changes in blood flow. The follicular diameter was calculated using the average height (H) and width (W) of the clear maximal image. The area (A) of a CL was determined by freezing the image at the maximum size to determine the H and W and then inserting the values into the following equation: A (mm²) =
The ovarian dynamics when a CL formed in the right ovary are shown in Fig. 2-a. The CL in the right ovary reached its maximum area on Day 11 (336.1 mm²), and its area remained unchanged between Day 18 and Day 27. Therefore, 25 mg of PGF2α (Dinoprost, Pronalgon F, Pfizer Japan Inc., Tokyo, Japan) was injected into the cow on Day 27, and ovulation was confirmed after 4 days. The RI values of the right ovarian artery (ROA) were higher than those of the left ovarian artery (LOA). Blood flow parameters of both uterine arteries are not significantly different during the estrous cycle [3]. That is, the existence of a CL or OF has no influence on uterine arterial blood flow [3]. Other studies have reported significant differences in the blood flows of the pregnant and non-pregnant uterine horn arteries 16 days after insemination [2, 6]. Ford et al. [6] reported that uterine blood velocity showed positive correlation with estradiol-17β and negative correlation with progesterone during the estrous cycle. In this study, the results indicate that the right uterine artery was present in spite of right uterine horn aplasia, but that the blood flow was very weak compared to that of the left uterine artery. We speculate that this weak blood flow might affect uterine and endometrium function, resulting in reduced PGF2α secretion from the endometrium and prevention of transportation for the uterine vein.

In this study, low RI values and high MnV values were observed in the side of the CL-bearing ovarian artery during the luteal phase. The higher blood velocity in the CL-bearing ovarian artery during the luteal phase is thought to be the effect of the corpus luteum acting as a low impedance shunt [6, 8]. In this case, aplasia of one uterine horn had no influence on the ovarian artery, and the changes in ovarian blood flow depended on the presence of a CL.

In conclusion, we found that the ipsilateral uterine blood flow with aplasia of one uterine horn is weaker than the contralateral uterine blood flow and revealed that aplasia of one uterine horn affects the estrous cycle, especially CL regression. Furthermore, the transrectal color Doppler technique is a valuable method of revealing abnormalities of the uterus and the condition of the genital tract blood supply.
Fig. 2. Ovarian dynamics, uterine blood flows, and ovarian blood flows in right side uterine horn-absent cow, when a corpus luteum formed in the right ovary. The day of ovulation was expressed as Day 0. PGF$_{2α}$ (↓) was injected on Day 27, and ovulation was observed on Day 31 (correlation coefficient of both arteries).

(a) Ovarian dynamics in both ovaries.
(b) RI values in both uterine arteries ($r = 0.82$, $p < 0.001$).
(c) MnV values in both uterine arteries ($r = 0.77$, $p < 0.001$).
(d) RI values in both ovarian arteries ($r = 0.60$, $p < 0.001$).
(e) MnV values in both ovarian arteries ($r = 0.39$, $p < 0.05$).

REFERENCES