Synchronization of the Estrous Cycle in Sows Using a Controlled Intravaginal Drug-releasing Device

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Abstract: *The aim of this study was to determine the effectiveness of an intravaginal drug-releasing device commercially produced for use in goats and sheep (CIDR-G device) at inducing estrus in sows. Thirteen Landrace sows were used in the this study, and the sows were randomly divided into three groups: group A (n=5), group B (n=4) and group C (n=4). Two CIDR-G devices were inserted into the vagina of each sow in groups A and B, and one CIDR-G device was inserted into the vagina of each sow in group C. The device was removed from each sow on the seventh day after insertion, and 0.2625 mg of $PGF_{2\alpha}$ was applied to the vulva of each sow in groups A and C. All five sows in group A and all four sows in group C, the two groups of sows that were administered $PGF_{2\alpha}$, showed onset of estrus 3–5 days and 2–4 days after removal of the CIDR-G device, respectively. Three of the four sows in group C showed onset of estrus on the second day after removal of the device. On the other hand, onset of estrus was observed (on day 3 after removal of the device) in only one of the four sows in group B, the group of sows that were not administered $PGF_{2\alpha}$. Saliva progesterone concentrations continued to rise in both groups A and C after insertion of the device, and the saliva concentrations of progesterone on day 5 after insertion in these two groups were significantly higher than those just prior to insertion of the device($p<0.05$). The number of devices inserted had no effect on the saliva progesterone concentration. The results of this study showed that insertion of a CIDR-G device for a period of seven days followed by application of $PGF_{2\alpha}$ to the vulva is effective for induction of estrus in the swine.*

Key words: *Sow, Synchronization, Controlled intravaginal drug-releasing device*

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One of the techniques necessary for performing artificial insemination or embryo transfer in swines is synchronization of the estrous cycle. Various techniques for artificially controlling the timing of onset of estrus in swines have been tested. In 1972, Hunter *et al.* [1] reported that ovulation was induced in gilts in the pre-estrus period approximately 40 hours after administration of human chorionic gonadotropin (hCG). Christenson *et al.* [2] reported that estrus was induced in sows in the post-lactation period at the desired times by treatment with a combination of pregnant mare's serum gonadotropin (PMSG) and hCG. Guthrie *et al.* [3] induced estrus by retrogressing the corpus luteum with the use of prostaglandin F 2 alpha ($PGF_{2\alpha}$) or a similar substance. Guthrie [4] investigated the possibility of synchronizing estrus in sows by administration of a combination of $PGF_{2\alpha}$, PMSG and hCG following formation of the corpus luteum induced by the administration of gonadotropin. Kawarasaki *et al.* [5] investigated the effectiveness of PMSG-hCG combination treatment in sows in the post-lactation period, sows in which abortion had been induced in the early stage of pregnancy, and gilts that had been administered oral synthetic progesterone, and they reported high rates of estrus induction in all groups. Due to the good results reported by Kawarasaki *et al.* [5], the PMSG-hCG administration method is currently used widely in Japan.

Recently, a method for inducing estrus in cows using a progesterone (P_4)-containing stick-shaped device has been used [6–9]. This device, known as a controlled intravaginal drug-releasing device (CIDR device), is inserted into the vagina for a certain period of time, and estrus is induced after its removal.

Since the sizes of swine, goat and sheep vaginas are similar, we carried out experiments to determine

whether estrus can be induced in sows after removal of CIDR devices used for goats and sheep.

Materials and Methods

Animals

Thirteen Landrace sows that had been raised at the Fukushima Animal Husbandry Experiment Station were used for the experiments. The average age of the sows was 1.5 years. All of the sows were in post-partum and had stopped lactating four months prior to the start of the experiments. The sows had all had several estrous cycles after lactating. The average weight of the sows was 277 kg. During the experimental period, the sows were fed twice daily, once in the morning and once in the evening, in accordance with the Japan Feeding Standards. Water was given ad libitum.

Hormone drug used and method of administration

Progesterone (0.33 mg) was administered to each sow via a controlled intravaginal drug-releasing device commercially produced in New Zealand for use in goats and sheep (CIDR-G device). The device is T-shaped with a plastic stem of 45 mm in length and 8 mm in diameter and wings with a span of 60 mm to prevent the device from falling out of the vagina.

The thirteen sows were randomly divided into three groups: group A (n=5), group B (n=4) and group C (n=4). Two CIDR-G devices were inserted into each sow in groups A and B, and the devices were removed on day 7 (day 0 being the day of insertion). In each of the sows in group A, 0.2625 mg of Cloprostenol ($PGF_{2\alpha}$) was applied to the vulva immediately after the removal of the CIDR-G device. One CIDR-G device was inserted into each sow in group C and removed on day 7. As in group A sows, 0.2625 mg of $PGF_{2\alpha}$ was applied to the vulva of each sow in group C immediately after removal of the device.

Confirmation of onset of estrus

Two technicians judged the onset of estrus by examinations of the vulva of each sow twice daily, in the morning and evening, over a period of 5 days and by observation of mounting when each of the sows had been placed in a pen with a boar following back pressure testing.

Saliva sampling

A saliva-sampling device was made by wrapping two layers of absorbent tissue paper around the tip of joined disposable-type chopsticks (20 cm in length) and then fixing the tissue paper to the chopsticks. Saliva was collected by inserting the sampling device into the oral cavity of the sow through the front part of the mouth and rubbing the tissue part of the device over the tongue and other parts of the mouth. Then the tissue part was cut at 7 cm from the tip of the chopsticks and placed in an empty outer cylinder of a 20-ml disposable plastic syringe. The outer cylinder was then placed, with the needle-attachment part facing down, in a 50-ml test tube, which was centrifuged at 3,000 rpm for 15 minutes. The supernatant obtained was stored at −30°C until use for measurement of P_4 concentration. Saliva sampling was done once daily, at 8 o'clock in the morning before feeding. The concentration of P_4 in saliva was measured using an enzyme immunoassay by the methods of Takeuchi *et al.* [10] and Tanaka *et al.* [11].

Results

Induction of estrus

Table 1 shows the number of sows in each group in which estrus was induced and the days after removal of the CIDR-G device on which estrus was induced. All five sows in group A and all four sows in group C, the two groups of sows that were administered $PGF_{2\alpha}$, showed onset of estrus 3–5 days and 2–4 days after removal of the CIDR-G device, respectively. Three of the four sows in group C showed onset of estrus on the second day after removal of the device. On the other hand, onset of estrus was observed (on day 3) in only one of the four sows in group B, the group of sows that were not administered $PGF_{2\alpha}$.

Changes in saliva concentrations of P_4

The mean saliva concentrations of P_4 just prior to insertion of the CIDR-G device were 21.8 ± 8.5 ng/ml in group A, 32.7 ± 2.9 ng/ml in group B and 22.1 ± 4.4 ng/ml in group C. The mean saliva concentrations of P_4 increased from the time of insertion of the device (day 0) until day 5 after insertion in groups A and C, and the mean saliva concentrations of P_4 on day 5 in group A (31.1 ± 2.8 ng/ml) and group C (31.6 ± 1.6 ng/ml) were significantly ($p<0.05$) higher than those on day 0. After removal of the device, the mean saliva concentrations of P_4 declined over a period of 7 days. The mean saliva concentration of P_4 in group A continued to decline gradually after the seventh day, and the mean concentration in group C showed a rapid decline from the second day after removal of the device. In group B, the mean saliva concentration of P_4 just prior to insertion of the device was 28.7 ± 2.3 ng/ml and, in contrast to the dramatic increases observed in groups A and C,

Table 1. Rates of estrus induction and days on which estrus was induced after removal of the CIDR-G device

Group	No. of sows used	No. (%) of showing estrus	No. (%) of sows showing estrus after removal of the devices at				
			1	2	3	4	5 days
A	5	5 (100)	0 (0)	0 (0)	2 (40)	1 (60)	2 (100)
B	4	1 (25)	0 (0)	0 (0)	1 (25)	0 (25)	0 (25)
C	4	4 (100)	0 (0)	3 (75)	0 (75)	1 (100)	

CIDR-G:Controlled intravaginal durg-release divece contained 0.33 mg of progesterone.

showed a gradual decline from the day of insertion of the device until the day of its removal.

Discussion

Since $PGF_{2\alpha}$ can only be used to control the timing of onset of estrus in sows when administered after the 12th day of the estrous cycle, its effectiveness in sows is not as good as that in cows [12, 13]. Christenson *et al.* [2] reported that estrus was induced at desired times in sows in the post-lactation period by administration of PMSG followed by administration of hCG 72 hours later. Guthrie *et al.* [4], who investigated the possibility of synchronizing estrus in sows by administration of a combination of $PGF_{2\alpha}$, PMSG and hCG following formation of the corpus luteum induced by the administration of gonadotropin, reported that both the rate of estrus induction and the rate of parturition when hCG was administered at 96 hours after the administration of PMSG were higher than those when hCG was administered at 72 hours after the administration of PMSG.

In the present study, we tested the effectiveness of a CIDR-G device for induction of estrus in sows. Although there have been no other reports on the use of a CIDR-G device in sows and, thus, a comparison of our results with results of other studies is not possible, the combined use of the CIDR-G device and $PGF_{2\alpha}$ induced estrus in 100% of the sows in the present study, suggesting that this method is very reliable. There have been reports on the effectiveness of the combined use of $PGF_{2\alpha}$ and a CIDR device in other animals. For example, Numabe *et al.* [14] reported that the combined use of $PGF_{2\alpha}$ and a CIDR-B device was more effective than the use of a CIDR-B device alone for induction of superovulation in Japanese Black cows, and James *et al.* [15] reported that estrus was induced in more than 90% of Holstein cows treated with $PGF_{2\alpha}$ within two to three days after removal of a CIDR-B device.

The fact that the saliva concentration of P_4 continued to increase gradually in the sows in the present study for five days after insertion of the CIDR-G device containing 0.33 mg of P_4 indicated that exogenous P_4 was absorbed in the sows. However, since we did not measure the levels of hormones other than P_4 in the present study, it is not clear why there was no difference between the mean saliva P_4 concentrations in sows in which only one CIDR-G device was inserted and that in sows in which two CIDR-G devices were inserted. Our results have shown, however, that the insertion of a CIDR-G device in sows for a period of 7 days regardless of the stage of the estrous cycle results in an increase in blood P_4 concentration in sows in which the endogenous P_4 level is low, and in maintenance of a sufficiently high blood concentration of P_4 in sows in which the endogenous P_4 level is high.

In conclusion, a CIDR-G device is effective at inducing estrus in sows regardless of the stage of the estrous cycle, and the use of this device should contribute greatly to the establishment of a reliable technique for embryo transfer. Based on the results of this study, insertion of one CIDR-G device for a period of seven days followed by application of 0.2625 mg of $PGF_{2\alpha}$ to the vulva appears to be appropriate for induction of estrus in the swine. Further studies using larger numbers of sows as well as endocrinological analysis are needed to establish the reliability of this technique for inducing estrus in sows.

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References

1) Hunter, R.H.S. (1972): Ovulation in the pig:Timing of the response to injection of human chorionic gonadotrophin. Res. Vet. Sci., 13, 356–361.
2) Christenson, R.K. and Teague, H.S. (1975): Synchronization of ovulation and artificial insemination of after lactation. J. Anim. Sci., 41, 560–563.
3) Guthrie, H.D. and Polge, C. (1978): Treatment of pregnant gilts with a prostaglandin anague, Cloprostenol, to control oestrus and fertility. J. Reprod. Fert., 52, 271–273.
4) Guthrie, H.D. (1979): Fertility after estrus cycle control using gonadotrophin and prostaglandin $F_{2\alpha}$ treatment of sow. J. Anim. Sci., 49, 158–162.
5) Kawarasaki, T., Sone, M. and Bamba, K. (1990): Synchronization of Estrus in Pig embryo Transfer. Jpn. J. Anim. Reprod., 36, 99–104(in Japanese).
6) Broadbent, P.J., Trewgaskes, L.D., Dolman, D.F., Franklin, M.F. and Jones, R.L. (1993): Synchronization of estrus in embryo transfer recipients after using a combination of PRID or CIDR-B Plus $PGF_{2\alpha}$. Theriogenology, 39, 1055–1065.
7) Iwazumi, Y., Fukui, Y., Vargas, R.B., Nakano, C., Sato, N., Furudate, M., Ohsaki, K. and Matsuzaki, S. (1994): Superovulation using CIDR in Holstein Cows. J. Reprod. Dev., 40, 259–266.
8) Macmillan, W.H. and Macmillan, K.L. (1989): CIDR-B for Managed Reproduction in beef cows and heifers. Proc. NZ. Soc.Anim. Prod., 49, 85–89.
9) Bai, X.J., Masuda, H., Kamura, Y., Fahrudin, M., Varisanga, M.D., Dong, Y.J., Otoi, T. and Suzuki, T. (200): Continuous superovulation treatment of Japanese black cows using a CIDR-B and GnRH. Jpn. J. embryo Transfer., 22, 85–91(in Japanese).
10) Takeuchi, K., Nakao, T., Moriyoshi, M. and Kawada, K. (1987): Clinical Evaluation of Progesterone Enzyme Immunoassay Kit for Cow's MIlk. J. Jpn. Vet. Med. Assoc., 40, 95–99 (in Japanese).
11) Tanaka, S., Nakao, T., Kawahara, T., Moriyoshi, M. and Kawada, K. (1988): A plasma progesterone enzyme immunoassay kit used for heifers. J. Jpn. Vet. Med. Assoc., 41, 83–97 (in Japanese).
12) Diehl, J. and Day, B. (1974): Effect of prostaglandin F 2 alpha on luteal function in swin. J. Anim. Sci., 39, 392–396.
13) Sugie, S. and Oguri, N. (1989): Synchronization of estrus of pig. In: Embryo Transter of Domectic Amimals. (Sugie, S. ed.), pp. 340–341, Yokendo, Tokyo.
14) Numabe, T., Oikawa, T., Kikuchi, T., Itou, H., Sato, H. and Horiuchi, T. (1997): Continuous superovulation treatment of Japanese cows using a progesterone agent (CIDR-B). J.Reprod. Dev., 43, j27–j32 (in Japanese).
15) James, C.A. (1999): The use of intravaginal progesterone releasing insert (CIDR) in embryo transfer. Jpn. J. Embryo Transfer, 21, 23–27.