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Efficacy of CIDR Treatment against Ovarian Follicular Cysts in Cows

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Summary

The objectives of this study were to identify cows with follicular cysts and study the efficacy of CIDR (Progesterone = 1.9 g) treatment against ovarian follicular cysts in Japanese Black and Holstein cows. Forty-one cows from Kagoshima Prefecture and Miyazaki Prefecture were initially identified by rectal palpation to have follicular cysts. These were randomly allocated into three groups where group 1 (n = 29) were treated with CIDR for 7 days, group 2 (n = 11) treated with CIDR for 14 days, and group 3 (n = 1) as the control group where no CIDR was inserted. After removal of CIDR, all animals received an intramuscular injection of 25 mg $PGF_{2\alpha}$. Fifteen out of 41 cows were confirmed to have follicular cysts after plasma progesterone determination by radioimmunoassay, as they had a pre-treatment progesterone concentration of < 1 ng/ml.

Four Holstein cows were treated with 7 days of insertion. The plasma progesterone concentration increased significantly ($P < 0.01$) after CIDR treatment i.e. day 0 (0.32±0.22 ng/ml) to day 21 (3.96±1.99 ng/ml). Eight Japanese Black cows with a pre-treatment mean plasma progesterone concentration of 0.32±0.26 ng/ml were treated with CIDR for 7 days where 7 of them (87.5%) had an increased post-treatment progesterone concentration of 3.66±1.54 ng/ml ($P < 0.01$). Three Japanese Black cows treated with 14 days of CIDR insertion had pre-treatment and post-treatment progesterone concentrations of 0.35±0.14 ng/ml and 2.40±1.86 ng/ml, respectively ($P = 0.09$).

Fourteen out of fifteen ovarian follicular cyst cases had increased progesterone levels 14 days after CIDR removal (post-treatment period), 11 cows (73.3%) came to estrus 2-6 days after removal of the CIDR device and ovulation of a dominant follicle occurred with following formation of the corpus luteum. The overall success rate of CIDR treatment against ovarian follicular cysts (increase in plasma progesterone concentration > 1 ng/ml) was 93.3% in both treated groups.

Key words: CIDR, cow, follicular cyst, progesterone, ultrasonography

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Introduction

Ovarian follicular cysts are anovulatory follicular structures that have been identified in a number of mammalian species [5, 22]. Cystic ovary disease affects primarily dairy cows although it has been reported occasionally in beef cattle. This difference is due to the more intensive management and treatment methods used on individual dairy cows [16]. Cows are infertile for as long as the condition persists [5]. Cystic ovarian disease prolongs the postpartum interval to first estrus in 10-30% of dairy cows [10, 13, 15]. Thus, ovarian follicular cysts are an important cause of infertility and economic loss for dairy farm enterprises.

Cystic ovaries, ovarian cysts, and ovarian cystic disease are all terms used synonymously with ovarian follicular cysts. The term has been used to describe the anovulatory condition in cows whereby a follicular structure grows to and surpasses ovulatory size but fails to ovulate. For dairy cows, cysts have been usually defined as anovulatory, follicular structures generally larger than 2.5 cm in diameter that persist for at least 10 days in the absence of a corpus luteum (CL). However, present information has suggested that this definition may no longer be appropriate [5, 22].

Two types of pathologic cysts are recognized, follicular and luteal [5, 13, 15]. Follicular cysts are usually thin-walled and secrete little progesterone; luteal cysts generally have thicker walls and secrete varying amounts of progesterone. Currently follicular cysts are between 2-3 times more common than luteal cysts [10]. Follicular cysts can progress to become luteal cysts through the luteinization process [13]. Another condition, cystic CL, is often confused with anovulatory follicular and luteal cysts. Cystic CL occurs following ovulation of a follicle and is characterized by a central cavity of varying size within an otherwise normal CL. Despite this morphological anomaly, a cystic CL is functionally normal and this condition does not appear to affect subsequent fertility [1].

The possible cause(s) of follicular cysts is not known, although a number of factors have been suggested. It has been observed that cows with cysts are associated with higher milk production than non-cystic herdmates [5]. The observation is biased however, according to Seguin [16], because higher-producing cows are more likely to be examined, more likely to be treated if found to have cystic ovarian disease, and more likely to be allowed to remain in the herd despite some decrease in reproductive performance. It also points out that ovarian cystic disease causes cows to produce more milk rather than that high production causes cows to develop the disease. It has also been suggested, although the results are equivocal, that diet and/or nutritional imbalance may be a cause [5]. Opsomer et al. [12] reported that insulin may be a possible factor in the pathogenesis of cystic ovaries on the link between metabolic disorders and cystic ovarian disease in high yielding dairy cows. It is also suggested that a gain in nutritional status prepartum can impair postpartum ovarian function, thus being a major risk factor for cyst development [9]. Hereditary predisposition has been implicated in dairy cattle where periparturient stress serves as a trigger. Data on 32 registered dairy herds from British Columbia (1993-1996, 7542 cows and 1247 lactations), showed that udder edema was directly associated with mastitis, metritis and cystic ovaries [14]. The mechanism by which the stress elicits the hypothalamic and pituitary defects in genetically predisposed cows is thought to be a relative deficiency in the release of luteinizing hormone (LH) at estrus. This may be a reflection of the failure of hypothalamic release of gonadotropin releasing hormone (GnRH). Another condition that can exist in some cows with cysts is a deficiency of LH and follicle-stimulating hormone (FSH) receptors in developing follicles [10, 22]. Follicles destined to form cysts secrete higher concentrations of estradiol than follicles that will ovulate normally, possibly due to their exposure to higher levels of LH. Despite the excessive secretion of estradiol, cystic cows do not release a preovulatory surge of LH [17]. Similarly, Hamilton et al. [6] were able to detect a higher mean concentration of circulating LH in cows with cysts than in cows with normal estrous cycles both near the time of detection of the follicle or cyst wave and near ovulation in the controls and when cysts reached ovulatory size.

Approaches to management of ovarian cysts have been reviewed recently [1, 19, 22]. Most cysts occur during the early postpartum period and prior to first ovulation [10, 13, 15]. Many cysts that occur during the early postpartum period recover spontaneously [10, 15]. Kamimura et al. [8] reported that 10 out of 64 lactating Holstein cows in their 2^{nd} -6^{th} parity that were used in the study of turnover of dominant follicles prior to first ovulation postpartum, developed cystic follicles. They have also reported that six out of ten cystic cows had recurrences of follicular cysts 2-4 times. Nevertheless, withholding treatment of cysts in anticipation of spontaneous recovery is less economical than treatment following diagnosis. In addition, early diagnosis and treatment are essential to minimize calving intervals of cows that develop cysts because the mean interval from treatment to conception is 50 days [5].

Diagnosis of ovarian cysts is commonly done through rectal palpation of the fluid-filled follicle-like structures (> 2.5 cm diameter), that are persistent for 10 days or more in the ovaries. The distinction between follicular and luteal cysts is, however, not possible through rectal palpation alone. Ultrasonographic pictures may also be used in the diagnosis of cystic ovaries. Confirmatory diagnosis depends on the progesterone levels in milk or blood plasma/serum. Some clinical signs may be present but have variations due to the duration of the condition and the nature of the hormone signal, or lack thereof from the diseased ovary.

Different approaches have been used so far for the treatment of cystic ovaries. The earliest reported method consisted of repeated manual removal or rupture of the cysts at 6 to 10 day intervals until redevelopment of the normal cycle and CL. However this treatment is not desirable and is contraindicated due to the trauma it can cause in the ovaries [15].

The use of LH as well as human chorionic gonadotropin (hCG) has been reported in treating ovarian cysts. GnRH or LH (hCG) and Prostaglandins ($PGF_{2\alpha}$) have been shown to have certain advantages in the treatment of cystic ovaries.

The proposed and apparently successful therapy for cows with cystic ovaries consists of injection of a luteolysing dose of Prostaglandin ($PGF_{2\alpha}$) which should involute all lutein tissue in the cystic ovarian structures, followed by a dose of GnRH or hCG 3 or 4 days after the injection of $PGF_{2\alpha}$ [15].

One of the most successful methods of therapy is the use of a progesterone releasing intravaginal device, PRID [10]. Presumably the progesterone (P_4) absorbed from the PRID suppresses the gonadotropin support that is required for the maintenance of the cyst, resulting in its demise. Following its withdrawal, there is a surge of gonadotropin with ovulation and CL formation. Thatcher et al. [19] suggested a treatment protocol with GnRH plus a controlled internal drug releasing (CIDR) device containing progesterone. Following treatment, a new follicular wave was established. $PGF_{2\alpha}$ was given on day 7, the CIDR removal on day 9 and estrus was reported to occur on day 11. Recently, CIDR treatment has been proved 80% effective in restoring ovulation and reestablishing normal cyclicity in beef donor cows with follicular cysts [20]. The CIDR was inserted for 14 days and within 3 days of its removal, estrus was detected followed by ovulation of the dominant follicle formed.

The objective of the present research is to determine the efficacy of CIDR insertion against ovarian follicular cysts in Holstein and Japanese Black cows.

Materials and Methods

Animals

The animals in the study were 41 cows (Holstein and Japanese Black) in the 3 different veterinary zones of Kurino, Satsuma, Isa and the University farm in Kagoshima Prefecture, and the Nishimoro veterinary zone in Miyazaki Prefecture, Japan. Cows were included in the study after meeting the following criteria: 1) diagnosis of ovarian cyst through rectal palpation by an experienced veterinarian during the routine herd health management program, 2) identification of a cystic structure with a minimum diameter of 25 mm by ultrasonography (for the cows in the University farm), 3) plasma progesterone level of less than 1 ng/ml and 4) being a minimum of 45 days postpartum.

All cows remained in the farm during the treatment period where they were kept as free stall animals and were fed wilted timothy silage and hay with concentrates depending on their milk yields (for Holstein cows) or according to the Japanese feeding standards (for Japanese Black cows).

Rectal palpation

Rectal palpations were performed by clinically experienced veterinarians in the respective veterinary zones of Kurino, Isa, Satsuma, Nishimoro and the University farm. The ovaries were considered to contain a cyst if a structure larger than 2.5 cm was palpated. Rectal palpation was performed on day -7 (pre-treatment period), on day 0 (day of CIDR insertion), on day 7 or 14 (day of CIDR removal) and on day 21 or 28 (evaluation day).

Ultrasonography examination

A linear array 7.5 MHz transrectal transducer and a B-mode real time ultrasound scanner (SSD-500, Aloka, Tokyo) were used. The rectum of the cow was emptied before insertion of the lubricated transducer and the ovaries were first located manually before placing the transducer on the site. Diameters of follicles were measured to the nearest 0.5 mm by means of electronic calipers located on the ultrasound device. Permanent images were recorded in freeze mode and printed by a printer connected to the ultrasound device.

Data on calving and puerperium

Data on calving and puerperium were obtained from the different farms' records after enquiries to the respective farms. These included the last calving date and the number of parities for the respective cows. Prevalence of stresses such as retained placenta, metritis, metabolic diseases at parturition, mastitis and lameness were noted accordingly as these may have an influence in the development of ovarian cysts.

Body condition scoring

Body condition scoring, BCS, was done on day 0 (D0) of the experiment with the BCS chart ranging from 1.0 - 5.0 with 0.25 divisions, where 1 indicates lean and 5 indicates obese.

Treatment protocol

The cows were randomly treated in a blind-study manner by insertion of CIDR (EAZI-

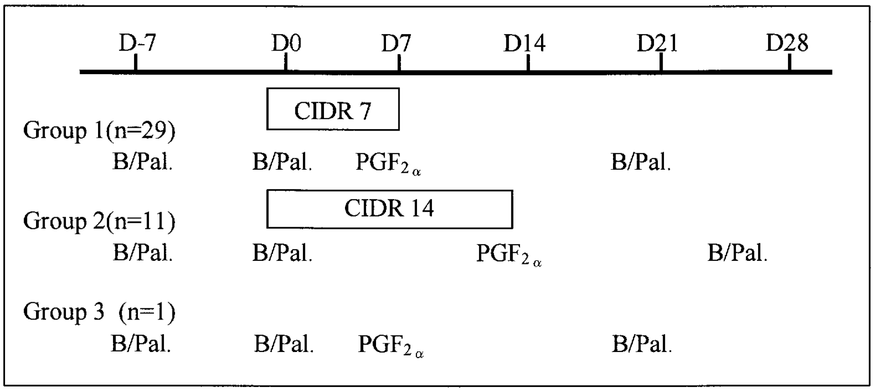
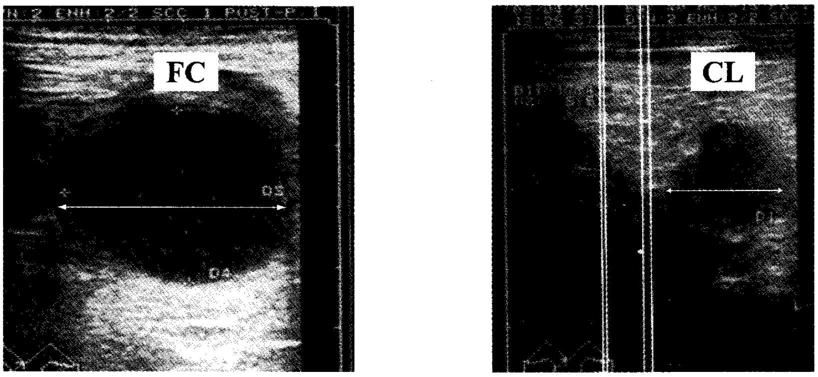


Fig. 1. Summary of the procedures carried out from the pretreatment period (D-7) to the post-treatment periods (D21 and D28).
Note: D - Days from CIDR insertion, B/Pal. - Blood sampling and Rectal Palpation (ultrasonography for cows in the University farm).



Before CIDR: FC   After CIDR: CL

Fig. 2. Follicular cyst (FC: diameter = 29.7mm) observed before CIDR treatment, and corpus luteum (CL: diameter = 17.4mm) formed after CIDR treatment. Vertical white lines in right figure are artifical.

BREED CIDR™, Inter Ag, Hamilton, NZ, containing 1.9 g progesterone). Cows undergoing CIDR insertion for 7 days formed group 1, those undergoing CIDR insertion for 14 days formed group 2 and some not treated with CIDR formed the control group 3. On CIDR removal or day 7 for the control group, an intramuscular injection of 25 mg $PGF_{2\alpha}$ (PRONALGON F™, Pharmacia Animal Health, Tokyo) was given (Fig. 1 and 2).

Blood collection and progesterone determination

Blood samples were collected from the jugular vein into heparinized tubes and centrifuged within 3 hours of collection at 4°C, 3000 rpm, for 15 minutes. The plasma samples were then stored at -20°C until the determination of progesterone by homologous double-antibody radioimmunoassay, RIA, by a method described by Taya et al. [18]. Plasma was used for progesterone determination rather than milk since in all the farms included in this study, milking is in the morning and evening which was inconvenient for the veterinarians involved in sampling. Blood samples were collected on D0 (pre-treatment period; day of CIDR insertion) and on D21 or D28 (post-treatment period; day of evaluation) for group 1 or group 2, respectively (Fig. 1 and 2).

Data collection and analysis

Cows with pre-treatment progesterone levels below 1 ng/ml after the RIA procedure qualified

Table 1. Efficacy of CIDR treatment against ovarian cysts grouped by cow breed, type of cyst and treatment.

Breed	Cyst[a]	Treat	Cow no.	Age	BCS[b]	Parity	PP d[c]	Pre P_4	Post P_4	P value[d]
H	FC	CIDR 7d	4	5.5	3.1	2.8	216.3	0.32	3.96	0.01
H	LC/CCL	CIDR 7d	8	5.3	2.8	3	191.8	4.12	3.22	0.18
JB	FC	CIDR 7d	8	7.6	2.7	5	73.4	0.32	3.66	0.001
JB	LC/CCL	CIDR 7d	9	8.3	3.1	5.7	65.8	4.18	3.92	0.40
JB	FC	CIDR 14d	3	7.7	2.8	5.3	158.3	0.35	2.4	0.09
JB	LC/CCL	CIDR 14d	8	9.4	3.4	6.9	119	4.77	1.38	0.04

a: FC - follicular cyst, LC - luteal cyst, CCL - cystic corpus luteum.
b: BCS - body condition score on a scale from 1 (lean) to 5 (obese).
c: PPd - postpartum period (days).
d: P values of the difference of progesterone levels between pre-treatment and post-treatment.

for the data analysis on the effectiveness of the treatment. Student's t-test was used for the analysis of pre-treatment and post-treatment progesterone levels where $p < 0.05$ was defined as significantly different.

Results

Forty-one cows (14 Holsteins and 27 Japanese Blacks) were identified by rectal palpation as having ovarian cysts i.e. fluid filled structures ≥ 2.5 cm diameter in one or both ovaries (Fig. 2). All cows were more than 45 days postpartum with a range of 45 days - 352 days. The cows were aged from 3 years to 18 years with parities ranging from 1 to 14.

The farms involved in the study use Artificial Insemination (AI) as their breeding system. There were no records of stresses such as retained placenta, metritis or metabolic diseases at parturition, mastitis or lameness for the animals under study. The milk production for the dairy cows in the study was between 20 kg/day - 40 kg/day. The body condition scoring ranged from 2.5 - 4.0

Diagnosis of follicular cysts

Out of the 41 cows that were diagnosed by rectal palpation to have cysts, 15 cows (37.5%) had a pre-treatment progesterone concentration below 1 ng/ml as a confirmatory diagnosis for follicular cysts. Group 1 (n = 29), comprising cows that were treated with CIDR for 7 days, included 12 Holstein cows. Four of these had a mean pre-treatment plasma progesterone concentration of 0.32 $\pm$0.22 ng/ml (mean$\pm$s.d.) and were confirmed to have follicular cysts. The other 8 Holsteins had a 3.96$\pm$1.99 ng/ml mean pre-treatment plasma concentration and were regarded as not having follicular cysts (Table 1). Out of 17 Japanese Black cows in group 1, 8 cows had follicular cysts i.e. the mean$\pm$standard deviation (SD) of pre-treatment plasma progesterone concentration was 0.32$\pm$ 0.26 ng/ml, whereas 9 of the Japanese Blacks had a mean pre-treatment plasma progesterone concentration of 4.18$\pm$2.56 ng/ml and were considered to have no follicular cysts. Group 2 (n = 11) consisted of only Japanese Black cows where 3 of them had follicular cysts with a mean pre-treatment plasma progesterone concentration of 0.35$\pm$0.14 ng/ml, while 8 of them had a 4.77$\pm$ 3.22 ng/ml mean progesterone concentration and no follicular cysts.

Fifteen cows out of the 41 study cows had pre-treatment progesterone concentrations ≥ 3 ng/ml. Seven of these cows, however, maintained the higher levels of progesterone even on the 14th day after CIDR removal (post-treatment period), while 5 of them showed estrus in 2 to 9 days

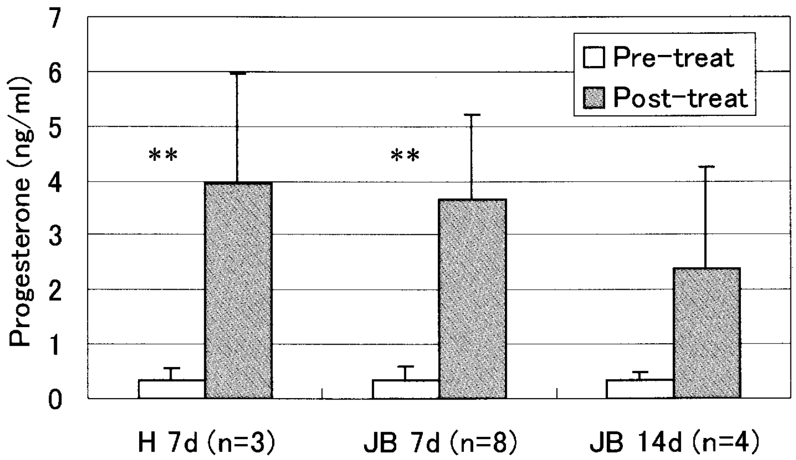


Fig. 3. Pre-treatment (day 0 of CIDR insertion) and post-treat (14 days after CIDR withdrawal) differences in plasma progesterone levels with CIDR treatment for 7 days or 14 days in Holsteins (H) and Japanese Blacks (JB) diagnosed with follicular cyst.
**: There was a statistical difference between the pre-treatment and post-treatment progesterone levels of in both the Holstein 7d group and the Japanese Black 7d group ($P < 0.01$).

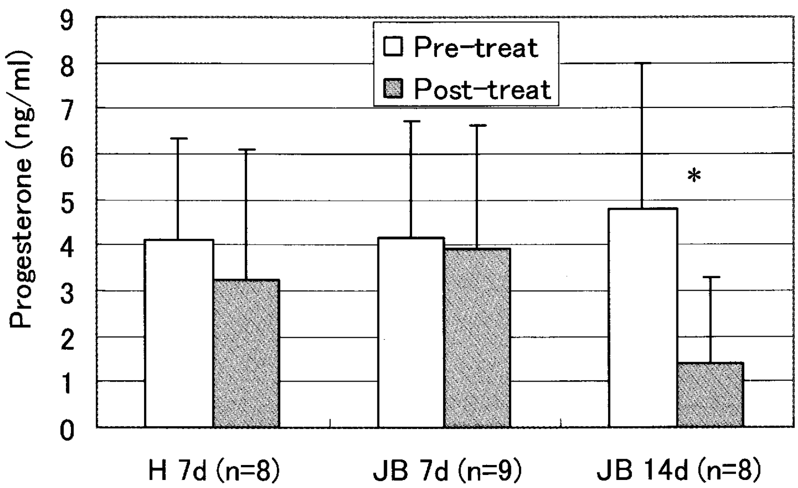


Fig. 4. Pre-treat (day 0 of CIDR insertion) and post-treat (14 days after CIDR pull) differences in plasma progesterone levels with CIDR treatment for 7 days or 14 days in Holsteins (H) and Japanese Blacks (JB) diagnosed with Luteal cyst or Cystic corpus luteum.
*: There was a statistical difference between the pre-treatment and post-treatment progesterone levels in Japanese Black 14d group ($P < 0.05$).

after CIDR removal.

Efficacy of CIDR treatment

Fifteen follicular cystic cows were treated with CIDR insertion for 7 days ($n = 12$) and CIDR for 14 days ($n = 3$) followed by injection of $PGF_{2\alpha}$ on the day of removal of CIDR. All four Holstein cows treated with CIDR for 7 days had ≥ 1.0 ng/ml post-treatment plasma progesterone concentrations, and the mean was 3.96 ± 1.99 ng/ml on day 14 after CIDR treatment. The Student's *t*-test for post-treatment progesterone concentrations against pre-treatment ones was $P = 0.014$, which was interpreted as a significant difference (Fig. 3). Out of 8 Japanese Black cows that were

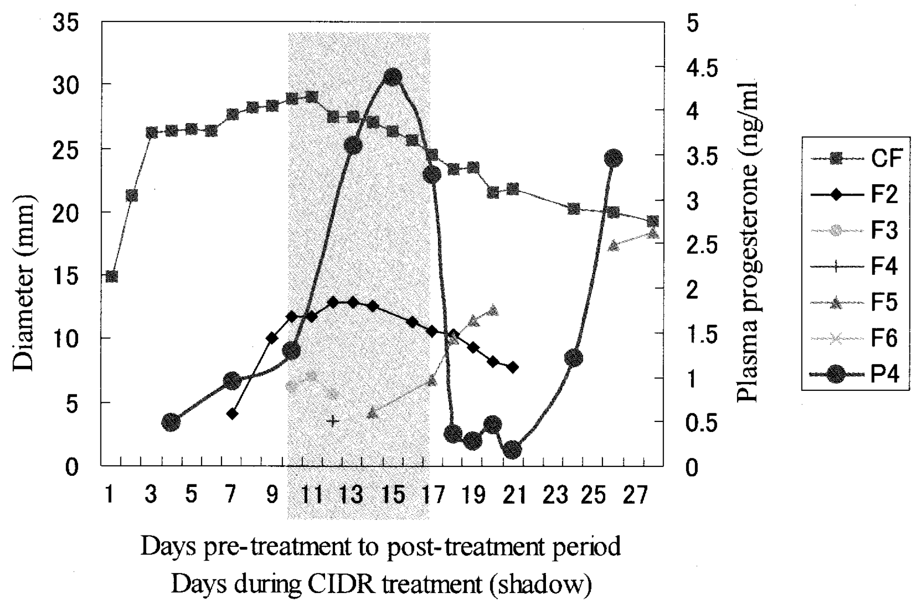


Fig. 5. Regression of cyst with formation of new follicular waves in relation to progesterone levels on treatments with CIDR.
Cystic follicle (CF) decreasing in diameter as the level of progesterone P_4 increases after CIDR insertion (7 days insertion), emergence of new follicles F4, F5 and F6; fall in progesterone level after removal of CIDR and injection of $PGF_{2\alpha}$ on day of CIDR removal, ovulation of dominant follicle (F5) and later the formation of corpus luteum (CL) with the final rise in progesterone level.

treated with CIDR for 7 days, 7 (87.5%) had $\geq$ 1 ng/ml post-treatment progesterone concentration, and the mean post-treatment plasma progesterone concentration was 3.66 ± 1.54 ng/ml. The Student's *t*-test for post-treatment progesterone concentrations against pre-treatment ones was P = 0.0004, which was interpreted as a significant difference. Three Japanese Black cows with follicular cysts treated with CIDR for 14 days had mean post-treatment plasma progesterone concentrations of 2.4 ± 1.9 ng/ml, and P = 0.09 when post-treatment and pre-treatment progesterone concentrations were compared.

After CIDR insertion, new follicular waves were initiated (Fig. 5). Estrus occurred and was reported in 11 of the 15 treated cows (73.3%) ranging from 2 to 6 days after CIDR removal in association with a new dominant follicle which ovulated ending in a formation of corpus luteum, CL (Fig. 2).

Twenty-five cows that had no follicular cysts i.e. had mean pre-treatment progesterone $\geq$ 1 ng/ml, were also treated with CIDR for either 7 or 14 days and $PGF_{2\alpha}$ injection on the day of CIDR withdrawal (Fig. 4). Holstein cows (n = 8) treated with CIDR for 7 days had mean pre-treatment progesterone concentrations of 4.12 ± 2.20 ng/ml, and the Student's *t*-test between pre-treatment and post-treatment progesterone concentrations was P = 0.18 (Table 1). Japanese Blacks (n = 9) were treated with CIDR for 7 days and $PGF_{2\alpha}$ injection on the day of removal of CIDR and had a post-treatment mean progesterone concentration of 3.92 ± 2.70 ng/ml. The Student *t*-test for progesterone concentrations between pre-treatment and post-treatment periods was P = 0.40. Eight Japanese Black cows were treated with CIDR for 14 days and had a 1.38 ± 1.90 ng/ml post-treatment progesterone concentration with the Student *t*-test giving a result of P = 0.038, when the mean pre-treatment and post-treatment progesterone concentrations were compared. Eleven of the 25 cows that had no follicular cysts but were treated with CIDR and $PGF_{2\alpha}$ on day of removal of

CIDR showed estrus within 9 days of CIDR withdrawal.

Discussion

The objectives of this study were to identify cows with ovarian follicular cyst, and to study the efficacy of CIDR treatment against ovarian follicular cysts. In this study rectal palpation was useful as a preliminary diagnosis of ovarian cysts. However, the presence of a follicular cyst was subsequently confirmed by hormonal assay for plasma progesterone levels. Rectal palpation alone could not correctly identify follicular cysts as shown by the fact that out of 41 cows, only 15 (36.6%) had true follicular cysts with plasma progesterone levels of < 1 ng/ml. This points out how difficult the differentiation of ovarian cysts is by rectal palpation. This is similar to earlier reports that diagnosis by rectal palpation has not been very accurate even when performed by experienced clinicians [2-5]. Farin and Estill [4] reported that approximately 10% of cystic ovaries diagnosed by rectal palpation had normal ovarian structures when examined by ultrasonography. They noted that a large corpus luteum adjacent to one or more large follicles was the most commonly misdiagnosed structure. This may be one of the reasons why many cows in this study had high pre-treatment progesterone concentrations. Some of them could be true luteal cysts and yet some may be normal ovarian structures like large CL.

Eleven (73.3%) of the cows in this study that were diagnosed with follicular cysts were Japanese Blacks which are beef cows. Many previous studies report that follicular cysts cause major economic losses in dairy farms [5]. Seguin [16] also noted that the observation that follicular cysts primarily affect dairy cows is due to the more intensive management and treatment methods used on individual dairy cows. However, the findings of this study prove the observation that the impact on commercial beef herds, although apparently minimal, goes undetected because of lack of postpartum examinations in most herds [4].

In the present study high progesterone concentrations (1.44 ng/ml and 4.14 ng/ml) were observed in 2 individual cows before treatment despite there being no ultrasonographic evidence of luteinisation or of active or regressing CL. Such secretion of progesterone by a cyst might be the cause of the block to cyclicity. The presence of significant plasma levels of progesterone suggests the possibility that a very thin rim of active luteinized cells in a cyst may synthesize and secrete progesterone, a possibility that could be investigated by a study of the histology and in vitro steroidogenesis of cystic tissue as suggested by Jeffcoate and Ayliffe [7]. Similar observations were reported earlier by Garverick, [5] that although accuracy with ultrasonography is much greater than rectal palpation, it is not absolute. He observed that for a few cows, cysts with echogenic areas that were similar to luteal tissue were not secreting progesterone, and that in a few cows, no echogenic patches were observed in cysts secreting progesterone.

In the findings of this study, 15 cows had a pre-treatment plasma progesterone concentration > 3 ng/ml and 7 of them came to estrus 2 - 8 days after removal of the CIDR and injection of $PGF_{2\alpha}$. Previous observations show that cows with regular estrous cycles have a mean progesterone concentration (MPC) $\geq$ 3 ng/ml on days 6 through to 18 of the 21- day cycle. Therefore cows with regular estrous cycles found at a random sampling to have MPC $\geq$ 3 ng/ml would be expected to come to estrus an average of 8 days after sampling [3]. In dairy cows the anestrous period after calving should not exceed 60 days. Animals which do not exhibit estrus signs during this period are regarded as pathologically anoestrous. However progesterone determination (and rectal palpation) may prove that silent heat may be the main clinical form of anoestrus in some cases.

In the 15 cows with follicular cysts treated with CIDR insertion for either 7 days or 14 days, the cyst regressed partially during the treatment period. Ovulation occurred and a corpus luteum was formed in 14 cows (93.3%) as supported by the raise in the level of circulating progesterone, whereas estrus was observed in 11 cows (73.3%). For the two cows that were monitored by ultrasonography, new follicular waves were initiated where a cohort of follicles was recruited, and one follicle was selected for further development until it ovulated. The ovulating follicle happened to be on the contra lateral ovaries. In some of the cows in this study, the CL of the ovulated follicles was palpated on the same ovaries with the original cyst. However it was not clearly determined whether it was the original cyst that had undergone ovulation or whether it was a new follicular structure that had developed at a different site on the same ovary. Earlier observations show that follicular cysts are not static structures and that they are characterized by turnover whereby the original cyst regresses, and a new follicular structure (cyst) develops at a different site on the same or contra lateral ovary [2, 8].

Ovulation and development of a CL were only detected after termination of the progesterone treatment. This was presumably a result of the inhibitory feedback effects of progesterone on the hypothalamo-pituitary axis on LH release [15]. Cystic ovaries in cows, as indicated earlier, are due to a failure of the normal release of LH. It is uncertain how treatment with progesterone brings about collapse of the cyst as noted earlier by Jeffcoate and Ayliffe [7]. Presumably the progesterone secreted from the intravaginal device suppresses the gonadotropin support that is required for the maintenance of the cyst, resulting in its demise. Following its withdrawal, there is a surge of gonadotropin with ovulation and CL formation [10]. Progesterone and similar products suppress the release and favor the storage of gonadotropin by the pituitary gland probably by acting upon the hypothalamus to prevent the release of GnRH [15].

The findings in this study show that the efficacy of CIDR is higher than that reported earlier by Noakes [10], where PRID was used with 68% of the cows recovering from follicular cysts within 13-18 days after the insertion of PRID, and following removal after 10-12 days there was estrus with ovulation and CL formation. It would therefore appear that the cyst had blocked the normal cyclic ovarian function, possibly by interfering with the ability of estradiol to induce a surge of luteinising hormone, as also observed and explained by Jeffcoate and Ayliffe [7]. Treatment overcomes the block and induces ovulation, permitting re-establishment of cyclic ovarian function. There was no evidence from the ultrasound images, for example, of a thickening and increasing echogenicity of the cyst wall that the follicular cyst luteinized after treatment, although this has been demonstrated in previous studies by Cook et al. [2].

Although this study was targeted on the efficacy of CIDR treatment against follicular cysts, findings of this study show that CIDR insertion followed by $PGF_{2\alpha}$ injection on CIDR removal were useful in treating the anoestrus condition in the other cows that were not diagnosed with follicular cysts. Twenty-five cows that did not express estrous behavior and were initially diagnosed by rectal palpation as containing ovarian cysts but had a pre-treatment progesterone concentration of > 1 ng/ml were also treated with CIDR and $PGF_{2\alpha}$ on CIDR withdrawal. Eleven cows showed estrus within 9 days of CIDR removal. Some of these cases may have been true luteal cysts and therefore as reported earlier, $PGF_{2\alpha}$ has been useful in treatment of luteal cysts by luteolysis [3, 4, 5, 21]. $PGF_{2\alpha}$ is only effective in the presence of active luteal tissue and presumably permits plasma gonadotropin concentration to increase as a consequence of luteolysis and thus trigger follicular development and ovulation.

The present study provides further evidence for the importance of prior exposure to progesterone for cows to express estrous behavior. Lack of immediate exposure to luteal concentrations of progesterone is thought to be the reason why many cows do not show estrous behavior in association with the first postpartum ovulation as also reported by Noble et al. [11].

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