J. Reprod. Fert. (1966) **12,** 193–198

EFFECT OF AN INTRA-UTERINE PLASTIC COIL ON THE OESTROUS CYCLE OF THE HEIFER

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(*Received* 31*st December* 1965)

Summary. A plastic coil was inserted surgically on Day 3 of an oestrous cycle into one uterine horn of each of ten heifers. Sham-operations were performed on five additional heifers. The oestrous cycles in which the CL was on the operative side were significantly shorter than the cycles in which the CL was on the non-operative side or the cycles of the sham-operated controls. The average cycle length when the CL was on the non-operative side was not significantly different from the cycle length of the sham-operated controls. These results indicate that a plastic coil in the cranial portion of one uterine horn of the heifer results in a unilateral 'inhibitory' influence on the CL.

INTRODUCTION

There is much experimental evidence which demonstrates that the uterus can influence the life-span of the corpus luteum (CL). Hysterectomy in many species causes a prolongation of luteal life, while uterine distention in ewes, guinea-pigs and cattle may cause a shortening of luteal life (Anderson, Bowerman & Melampy, 1963). Recently there have been reports of local utero-ovarian relationships. Du Mesnil du Buisson (1961) has reported that partial hysterectomy of gilts is followed by maintenance of the CL on the side of uterine removal and regression on the side of a retained uterine fragment. A similar unilateral phenomenon has been reported to occur following unilateral hysterectomy of guinea-pigs (Fischer, 1965). A unilateral 'inhibitory' influence on the CL occurs in the ewe following the insertion of a plastic coil into the cranial portion of a uterine horn (Ginther, Pope & Casida, 1965). The oestrous cycles are shorter and the CL smaller when the coil is located in a uterine horn adjacent to the ovary containing the CL than when the coil is in a horn opposite to the ovary containing the CL.

The present study was designed to determine if a unilateral 'inhibitory' influence on the CL, similar to that reported for ewes, occurs in heifers following the insertion of an intra-uterine plastic coil.

MATERIALS AND METHODS

One polyethylene plastic coil was inserted at oestrus into one uterine horn of

each of eight Holstein heifers during a preliminary study of methods. Insertion was accomplished by forcing the coil into a metal tube and then guiding the tube into the uterus by rectal manipulation of the cervix. The coil was then ejected into the uterus with a plunger after which the coil tended to regain its original shape. Following coil insertion each heifer was allowed to complete two oestrous cycles. The side of ovulation and CL formation and the position of the intra-uterine coil was determined for each cycle by periodic rectal palpation.

The post-treatment cycle lengths of these eight heifers did not suggest a unilateral inhibitory effect of an intra-uterine coil on the CL. However, this method of coil insertion resulted in considerable variability in coil position and shape. Some coils, but not others, were tightly coiled within the horn. In addition, it was found impractical to place the coil into the cranial portion of the horn. It was thought that these difficulties may have prevented the manifestation of any unilateral utero-ovarian effects. Consequently, the technique of insertion was changed, as described below, to assure uniformity in coil position and shape, and to enable it to be placed and anchored well forward in the uterine lumen.

Fifteen Holstein heifers, weighing 400 to 500 kg, were used in the main study. The heifers were observed twice daily for oestrus before and throughout the experimental period. Only animals that exhibited one or two cycles of normal length (18 to 24 days) immediately before treatment were used. At the time of the pre-treatment oestrus, the fifteen heifers were assigned in rotation to one of three groups: (1) coil to be inserted into the uterine horn adjacent to the ovary of ovulation; (2) coil to be inserted into the uterine horn opposite to the ovary of ovulation; and (3) sham-operated controls. For this report, a CL in an ovary adjacent to the horn containing the coil is described as being on the 'operative side'; a CL in an ovary opposite to the horn containing the coil is described as being on the 'non-operative side'.

The coils were prepared from polyethylene plastic rod, 3 mm in diameter. A length of rod was tightly coiled around a wooden dowel (diameter, 16 mm) and fastened at both ends with thumb tacks. The coiled rod was then boiled in water for 6 min and immediately cooled with water before removing from the dowel mount. The coiled rod was then divided into coils which were approximately 20 mm in length and 22 mm in diameter.

Surgery was performed under general anaesthesia on Day 3 of an oestrous cycle, hereinafter referred to as the 'immediate' oestrous cycle (oestrus, Day 1). The heifers were isolated from water and feed for 36 to 48 hr before surgery. Fifteen minutes before anaesthesia, 4 to 6 ml of a tranquillizer containing propiopromazine (Tranvet, Diamond Laboratories, Inc., Des Moines, Iowa), was administered intravenously. Six heifers (two replicates) were anaesthetized with electro-anaesthesia (Electronic Medical Instrument Co., Loveland, Colorado, U.S.A.). The remaining nine heifers were anaesthetized by intravenous administration of a chloral-hydrate, magnesium sulphate preparation (Chloral-Mag, Norden Laboratories, Lincoln, Nebraska, U.S.A.). The anaesthetized heifers were secured in dorsal recumbency with caudal elevation in a surgical cradle similar to that described by Neal & Nelson (1962). The ovaries and uterus were exposed by means of a mid-ventral laparotomy aided by a large incision

retractor. The side of ovulation (right or left ovary) was recorded. Of the five heifers which had been assigned to receive a coil on the side of ovulation, three had ovulated from the right ovary and two from the left. Of the five heifers which had been assigned to receive a coil opposite to the side of ovulation, two had ovulated from the right ovary and three from the left.

Before coil insertion a 10 cm length of heavy Vetafil surgical suture (Norden Laboratories) was attached to one end of each coil to facilitate anchoring the coil to the uterine wall. For insertion the plastic coil was reduced in diameter by twisting and then placed into the tip of a blunted number 7 cork-borer (diameter, 14 mm). The instrument containing the reduced coil was then inserted through a longitudinal, antimesometrial incision in the caudal portion of the horn and pushed forward in the uterine lumen to a point 6 to 12 cm from the tip of the horn. The coil was then ejected with a plunger into the uterine lumen. A long, straight needle was threaded onto the length of Vetafil suture which had been previously attached to the coil and now trailed through the uterine incision. The threaded needle was carried forward within the uterine lumen with a haemostat and pushed through the uterine wall near the caudal end of the coil. The coil was then sutured to the uterine wall with the Vetafil suture. The coil tended to regain its original diameter causing a localized distention in the cranial portion of the uterine horn. The uterine incision was closed with No. 00 chromic catgut.

The sham-operation in four cases consisted of all of the above procedures, including insertion of the blunted cork-borer into the uterine lumen, but without insertion of a coil. Two of the heifers were sham-operated on the side of ovulation, and two on the opposite side. A uterine incision was not made in the fifth sham-operated heifer.

Following recovery from anaesthesia the heifers were again observed twice daily for oestrus. Rectal palpation was performed every other day in all animals and the location and estimated size of CL and follicles and the position of the uterine coil recorded.

An analysis of variance and Tukey's multiple range test (Steel & Torrie, 1960) were used to analyse differences in cycle lengths. The immediate cycles were analysed separately from the subsequent cycles. This was thought advisable since the location of the newly-forming CL was verified for the immediate cycles at the time of surgery, but the location of the CL of the subsequent cycles was based only on rectal palpation. If the CL of two subsequent cycles of a given heifer were both on the operative side, or if both were on the non-operative side, the average of the two was used in the analysis. Similarly, the average of the two subsequent cycles of each sham-operated control heifer was used.

The heifers were killed on Day 8 following the third post-operative oestrus. However, one heifer was killed on Day 8 after the first post-operative oestrus because the side of ovulation for the first post-operative oestrus could not be determined by rectal palpation. The CL were dissected free and weighed. They were then cut in two, drained and re-weighed to obtain the weight of luteal tissue (weight after draining) and the weight of the fluid contents of any luteal cavities or cysts (total weight minus weight after draining). The endometrium was inspected, grossly, for evidence of inflammation.

RESULTS

The side of the uterine incision in the sham-operated heifers did not appear to influence the oestrous cycle lengths differentially, and therefore the data for the sham-operated heifers were combined. Of the fifteen immediate oestrous cycles, the five cycles with CL on the operative side were significantly shorter than either the five cycles with the CL on the non-operative side or the cycles of the five sham-operated controls ($P<0{\cdot}01$) (Table 1). Similarly, of the subsequent cycles, the cycles with the CL on the operative side were significantly shorter than the cycles with the CL on the non-operative side or the cycles of the sham-operated controls ($P<0{\cdot}01$). The average cycle length when the CL was on the non-operative side was not significantly different from the cycle length of the control heifers for either the subsequent or the immediate oestrous intervals. In most cases, when an immediate and a subsequent cycle of a given heifer both occurred with the CL on the operative side, the subsequent cycle was shorter than the immediate cycle ($P<0{\cdot}1$). Two subsequent cycles, both of

TABLE 1

EFFECT OF AN INTRA-UTERINE PLASTIC COIL ON OESTROUS CYCLE LENGTH AND CORPUS LUTEUM WEIGHT

Comparisons	*Location of corpus luteum in heifers with coils*		*Sham-operated control heifers*	*Error mean squares*
	Operative side	*Non-operative side*		
Length of immediate cycles* (days)	14·0[a] (5)†	20·4[b] (5)	21·4[b] (5)	6·49
Length of subsequent cycles (days)	12·6[a] (7)	20·2[b] (6)	20·7[b] (5)	9·76
Weight of corpora lutea‡ at Day 8 (g)	3·44[a] (5)	3·85[a] (3)	4·43[a] (5)	1·10

[a, b] Means in the same row bearing different superscripts are significantly different from each other ($P<0{\cdot}01$).

* Coil inserted in one uterine horn on Day 3 of the immediate oestrous cycle.

† Numbers in parentheses indicate the number of heifers from which the mean was derived.

‡ Weight of corpora lutea after draining fluid from cavities or cysts. The heifers were autopsied on Day 8 following the third post-operative oestrus.

normal length, were omitted in the statistical analyses, since in one case the side of ovulation could not be determined by rectal palpation, and in the second case the coil became displaced during the early part of the cycle and lodged in the cervix.

Development of CL to palpable size occurred during the early oestrous cycle whether the CL were on the operative side or the non-operative side. The maximum estimated diameter of CL when on the operative side averaged 20 mm and was reached on Day 9. The averages when the CL were on the non-operative side were 23 mm at Day 14 and for the sham-operated controls, 22 mm at Day 12. This estimate, from rectal palpation, of substantial CL development in the early part of the oestrous cycle, in all three groups, was supported by the weight and the normal appearance of the CL at slaughter on Day 8. Although apparently there was a trend for the CL on the operative side to be somewhat smaller, a statistically significant difference in CL weight was not detected

between the three experimental groups (Table 1). Evidence for the formation of cystic CL was not obtained. Comparison of the weight of fluid drained from the sectioned CL revealed no significant differences between the three groups. The CL of two heifers were excluded from these data, since the coil had become dislodged. According to rectal palpation, in one case this occurred at about the time of the second post-operative oestrus and the coil lodged in the cervix. In the second case it occurred at about the time of the third post-operative oestrus and the coil lodged in the uterine body.

There was inflammation of the endometrium in the area of the coil at autopsy. In most cases there was some yellow exudate clinging to the coil. The rest of the endometrium grossly appeared to be normal.

DISCUSSION

The occurrence of shorter oestrous cycles when the CL was in the ovary adjacent to the horn containing the coil indicates that a plastic coil in the cranial portion of one uterine horn of the heifer results in a unilateral 'inhibition' of the CL. The failure of precocious oestrus to occur in sham-operated heifers or in heifers in which the coil had become dislodged indicates that the effects were due to the presence of the coil rather than to other effects of surgery. Failure to demonstrate a unilateral effect in the preliminary studies when the coil often was in the caudal portion of the horn, suggests that cranial location of the coil may be important for the manifestation of a unilateral effect. The palpation and autopsy results suggest that much of the decrease in CL size associated with the precocious oestrus occurred, on average, later than Day 8.

The unilateral effect continued to occur throughout the experimental period of three oestrous cycles provided the coil remained in place. The continuing effect of a coil was observed in a heifer that had not ovulated by the time of surgery and was therefore replaced by another animal. However, a coil was inserted and the side of ovulation determined by rectal palpation. She had two cycles of 18 and 21 days when the CL was on the non-operative side and four cycles of 10 to 12 days when the CL was on the operative side, precocious oestrus continuing to occur over 2 months from the time of surgery.

The shortened oestrous cycles reported herein are in general agreement with previous reports of precocious oestrus following uterine distention in cattle (Yamauchi & Nakahara, 1958; Hansel & Wagner, 1960; Chatterjee & Luktuke, 1961; Yamauchi, 1963; Hawk, Conley, Brinsfield & Righter, 1964). However, previous experiments in cattle were not designed to test the relationship between the side of CL location and the side of uterine distention as related to the resulting cycle length.

ACKNOWLEDGMENTS

Paper No. 1056 from the Genetics Laboratory, published with the approval of the Director of the Agricultural Experiment Station. This work was done under a co-operative agreement between the Wisconsin Agricultural Experiment Station and the Dairy Cattle Research Branch, U.S.D.A. The work was supported in part by the Branch and also by a grant from the Ford Foundation. One of us (O.J.G.) was supported by a United States Public Health Service

post-doctoral fellowship, No. 1 F2 HD-23, 054-01, from the National Institute of Child Health and Human Development.

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