# Effects of Synovex® Implants on Growth Rate, Pelvic Area, Reproduction, and Calving Performance of Replacement Heifers

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# Effects of Synovex C® Implants on Growth Rate, Pelvic Area, Reproduction, and Calving Performance of Replacement Heifers[1,2]

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**ABSTRACT:** Two trials were conducted to evaluate effects of Synovex C® implants on replacement heifers, given at two different ages. Crossbred heifer calves (n = 370) were allotted to four treatments: 1) non-implanted controls, 2) implanted at 2 mo, 3) implanted at 6 mo, and 4) implanted at both 2 and 6 mo of age. Heifers implanted at 2 mo gained 7 kg more ($P$ = .01) by 6 mo than those not implanted at 2 mo. No differences were found in 22-mo weights. All implanted heifers had larger ($P$ = .01) yearling pelvic area than controls. All heifers implanted at 6 mo continued to have larger ($P$ = .01) pelvic area at 22 mo. All implanted heifers had higher ($P$ = .05) occurrence of non-ovulatory estrus. No differences were found among treatments in percentage of heifers puberal before breeding, in estrus first 21 d of breeding, or in first-service conception rate. In only one trial, pregnancy first 21 d and total pregnancy in 63-d breeding season were decreased ($P$ = .05) by implanting at 6 mo. At subsequent calving, an interaction existed between the effects of the 2- and the 6-mo implant for calf birth weight and pelvic area:birth weight ratio. A single implant at either 2 or 6 mo decreased ($P$ = .01) calving difficulty score; and implanting at both 2 and 6 mo showed the greatest reduction in calving difficulty. Implants had no significant long-term effects on reproduction or calf production of 2-yr-old cows. Results showed implanting at 2 mo of age increased early weight gain and decreased calving difficulty scores; implanting at 6 mo increased precalving pelvic area and decreased calving difficulty scores; and implanting at both 2 and 6 mo increased early weight gain, decreased calving difficulty scores, but tended to reduce early fertility.

Key Words: Estradiol, Heifers, Growth, Pelvis, Reproduction, Calving

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## Introduction

Proper management of replacement heifers is an important step in developing a productive cow herd. Heifers should reach puberty at a young age to assure high conception rates early in the first breeding season (Lesmeister et al., 1973). Replacement heifers should also reach adequate skeletal development to minimize dystocia. Although growth-promoting implants are used in suckling calves to increase gain, until recently they have not been recommended for replacement heifer calves because of possible detrimental effects on fertility.

Ralgro® (Pitman-Moore, Mundelein, IL) implants (36 mg of zeranol) in replacement heifer calves increased weight gain and yearling pelvic area (Staigmiller et al., 1983; Deutscher et al., 1986; Bolze and Corah, 1988), but only Deutscher et al. (1986) reported larger precalving pelvic area. A single implant at 1 to 6 mo of age had little effect on yearling pregnancy rates (Sprott et al., 1979; Simms, 1982; Deutscher et al., 1986; Bolze and Corah, 1988).

Less research has been conducted on Synovex C® (Syntex Agribusiness, West Des Moines, IA) implants (10 mg of estradiol benzoate and 100 mg of progesterone). These implants have increased weaning and yearling weights and yearling pelvic area (Carpenter and Sprott, 1991; McCraw et al., 1991; Whittier et al., 1991; Rusk et al, 1992), but effects on precalving pelvic area and dystocia are not known. Synovex C® implants did not significantly affect yearling pregnancy rates in some studies (Carpenter and Sprott, 1991; Whittier et al., 1991); however, Rusk et al. (1992) reported a reduction. Therefore, more research is needed to determine the effects of Synovex C® implants on reproduction and dystocia.

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The objective of this study was to evaluate the effects of Synovex C® implants on replacement heifer calves, when implanted at 2 and(or) 6 mo of age, on growth traits, pelvic area, puberty, pregnancy rate, and calving performance.

## Materials and Methods

In May 1988, Trial 1 was initiated using 180 Meat Animal Research Center (**MARC II**) composite heifer calves (1/4 Angus × 1/4 Hereford × 1/4 Simmental × 1/4 Gelbvieh), and Trial 2 began in May 1990 using 190 MARC II heifer calves. In both trials, the calves were born in the spring and grazed with their dams (without creep feed) during the summer on native pasture at the Gudmundsen Sandhills Laboratory (**GSL**) near Whitman, NE. The heifer calves were randomly allotted by age and birth weight into one of four Synovex C® treatment groups: 1) control, no implant; 2) implanted at approximately 2 mo of age (branding); 3) implanted at approximately 6 mo of age (weaning); and 4) implanted at both 2 and 6 mo of age. Heifer calves were weighed at each implantation time. A mixture of salt and dicalcium phosphate (1:1) was available ad libitum to the heifers throughout the experiment.

After weaning in October, the heifers were transported to the West Central Research and Extension Center (**WCREC**), North Platte, NE and placed in drylots. In Trials 1 and 2, heifers were fed a diet of alfalfa hay, corn silage, and corn from weaning to breeding and gained .59 and .50 kg/d, respectively. Growth traits for both trials were measured at 6 (weaning), 12 (yearling), 18 (pregnancy check), and 22 (precalving) mo of age. Growth traits consisted of body weights and hip heights. Body condition scores were given on a visual scale of 1 to 9, where 1 = emaciated; 5 = moderate; and 9 = extremely fat. Udder development scores were recorded at 6, 9, 12, and 18 mo of age on a visual scale of 1 to 4, where 1 = normal teat and udder development and 4 = extreme teat and udder development. At calving, udder scores were recorded on a visual scale of 1 to 3, where 1 = small udder and 3 = large udder. Body condition and udder development scores were consistently recorded by one experienced technician and one investigator, respectively.

External and internal pelvic measurements were also taken at 6, 12, 18, and 22 mo of age. External measurements consisted of width of pins, width of hooks, and hooks to pins. These measurements were taken only on Trial 1 heifers. In both trials, internal pelvic measurements, consisting of pelvic height and width, were taken using a Krautman Bovine Pelvic Meter (Jorgensen Laboratories, Loveland, CO) by one experienced investigator. Pelvic height was the vertical distance between the sacral vertebrae and pubic symphysis, and pelvic width was the horizontal distance between the shafts of the ilium (at the widest point). Pelvic area was the product of the height times the width.

At WCREC, from weaning until the start of the breeding season, heifers were observed twice daily, morning and evening, for standing estrus. Androgenized steers were used to help detect heifers in standing estrus. Between 7 and 14 d after being detected in standing estrus, the heifers were bled via jugular vein and ovaries palpated via rectum for corpora lutea. Blood samples were also collected twice, 10 d apart, and ovaries were palpated before the start of the breeding season. Blood samples were chilled for 24 h, centrifuged, and the serum was decanted and frozen until they were analyzed. Serum progesterone was quantified using radioimmunoassay (Anthony et al., 1981). Date of puberty for each heifer was determined from the concentration of serum progesterone ($\geq$ 1.45 ng/mL) and date of estrus or palpable corpora luteum. Percentage of heifers puberal before the start of the breeding season was determined from date of puberty.

A 63-d breeding season was used in both trials and began May 1, 1989 and May 20, 1991 for heifers in Trials 1 and 2, respectively. During the first 21 d of the breeding season, heifers remained in drylots and were observed twice daily for standing estrus. Approximately 12 h after they were observed in standing estrus, heifers were artificially inseminated. Both trials used one sire throughout the 21-d AI period, but each trial used a different sire. A Red Angus sire (birth weight EPD of –5.3, 90% accuracy) and a Black Angus sire (birth weight EPD of –1.8, 89% accuracy) were used in Trials 1 and 2, respectively. Three technicians inseminated heifers in each trial. Each technician artificially serviced approximately the same number of heifers per treatment. At the end of the AI period, heifers were exposed to yearling bulls with below average birth weights for natural mating in drylots for 2 wk. During this period, the heifers and bulls were observed twice daily to obtain breeding dates.

During the first 5 wk of the breeding season in drylots, the heifers' diet was similar to the diet during the weaning to breeding period. After the drylot period, the heifers and bulls were moved to native pasture.

Pregnancy examinations were performed 50 d after the end of breeding season. Heifers diagnosed not pregnant were ovariectomized; and ovaries were weighed and examined for any abnormalities. The percentage of heifers cycling was determined from the presence of corpora lutea and(or) corpus albicans.

Conception dates were determined from breeding dates and calving records. Pregnant heifers in Trial 1 remained at the WCREC, where they grazed cornstalks and were supplemented with alfalfa hay until calving. In Trial 2, pregnant heifers were transported to GSL after pregnancy check. These heifers grazed winter meadow and were supplemented with meadow hay and protein cubes until 22 mo of age when they were returned to WCREC for calving.

In both trials, pregnant heifers were placed in drylots before calving. Heifers in Trial 1 were fed corn silage and alfalfa hay, whereas heifers in Trial 2 were fed brome and alfalfa hay. Heifers were scored on a scale of 1 to 5 on the degree of calving difficulty, where 1 = no assistance; 2 = hand pull; 3 = easy mechanical pull; 4 = major mechanical pull; and 5 = Caesarean. Those heifers with abnormal presentations and twins were deleted from the analysis. Calf vigor scores were recorded on the scale of 1 to 5, where 1 = nursed unassisted within 30 min, 2 = nursed unassisted within 30 to 60 min, 3 = nursed unassisted within 75 min, 4 = did not nurse within 75 min and was assisted, and 5 = dead at birth. Calf birth date, sex, and birth weight were also recorded.

Two-year-old cow reproduction and production traits were collected across treatments on 100 cows in Trial 1 and 146 cows in Trial 2 to determine long-term effects of implants. After the calving season, cows and calves in both trials were returned to GSL for summer grazing. Cows were exposed to MARC II bulls for a 60-d breeding season beginning June 5 each year, and calves were weighed and weaned in September. Milk production estimates were obtained by the calf weigh-suckle-weigh method on 15 cows per treatment in Trial 1 and 10 cows per treatment in Trial 2. Estimates were obtained at approximately 30, 90, and 150 d postpartum. Second calving data were also collected.

Data were analyzed by analysis of variance with effects of trial, treatment, and trial × treatment in the model. Percentage data were analyzed by chi-square procedures for individual trials and by logit transformation (Pindyck and Rubinfeld, 1981) for the total data set. Trial, treatment, and their interaction composed the model for the transformed data. Three orthogonal comparisons were used to test sources of treatment differences (Treatments 1 and 3 vs 2 and 4 = effect of 2-mo implant; Treatments 1 and 2 vs 3 and 4 = effect of 6-mo implant; Treatments 1 and 4 vs 2 and 3 = interaction of implanting at 2 and 6 mo). Calf sex and sire effects were in the models for the analyses of calf birth weight, vigor score, calving difficulty, gestation length, and calf weaning weight.

## Results and Discussion

### *Growth Traits and Pelvic Area*

No interactions were found due to implanting at 2 and 6 mo of age. Thus, the discussion is on the effects of either the 2- or 6-mo implant.

*Heifer Weight.* Growth measurements at various ages for both trials combined are reported in Table 1. Heifers implanted at 2 mo gained 7 kg more ($P$ = .01) from 2 to 6 mo of age than non-implanted heifers. This agrees with previous research (Whittier et al., 1991; Rusk et al., 1992), which showed increases in weaning weights. Heifers implanted at 2 mo were heavier ($P$ = .01) at 12 mo of age than control heifers. Whittier et al. (1991) reported an increase in yearling weight due to a 2-mo implant. Heifers implanted at 6 mo exhibited no extra growth due to this implant. The Synovex C® implant is designed to increase growth rate in suckling calves under 182 kg; therefore, heavier heifers at 6 mo may not show an increase in weight gain because of the low dosage in Synovex C®. Implanting at 2 mo, increased heifer weight at 18 mo; but no differences were found in heifer weights at 22 mo among treatments in the present study.

*Hip Height.* No differences were found in hip height among treatments at 6 and 12 mo of age (Table 1). Implanted heifers were shorter ($P$ = .05) at 22 mo than control heifers. These results do not agree with the theory that the estrogenic properties of the implants increase long-bone growth, thus increase hip height (Carpenter and Sprott, 1991). However, our results are similar to Whittier et al. (1991), who reported heifers implanted at 2 mo of age were shorter than non-implanted heifers at 18 mo (126 vs 128 cm) and before calving (130 vs 132 cm). The implants may cause early maturation of the epiphyseal plates of the long bones and retard growth. McCraw et al. (1991) reported no differences in hip height measurements among treatments when heifers were implanted at 2 to 3 mo of age.

*Condition Score.* Implanting at 2 mo increased body condition score at 12, 18, and 22 mo of age (Table 1). Along with muscle growth, heifers implanted at 2 mo of age had moderate fat deposition, which continued to 22 mo of age. Implanting at 6 mo increased ($P$ = .04) condition score only at 22 mo of age.

*Udder Development.* Udder development scores were greater ($P$ = .01) at 6, 9, and 12 mo of age due to the implant at 2 mo (Table 1). The implant at 6 mo of age increased ($P$ = .01) udder score at 9, 12, and 18 mo. This increase in udder development was likely due to the estrogenic properties in the implant that stimulates mammary growth (Sejrsen, 1984). An increase in udder size may lower sale value of implanted heifers. At calving time, implants had no significant effect on udder scores.

*Pelvic Area.* The implant at 2 mo increased pelvic area ($P$ = .01) at 6, 12, and 18 mo of age (Table 1), increasing yearling pelvic area by 9 $cm^2$. These results are in agreement with other research in which implants increased pelvic area at 12 mo of age (Carpenter and Sprott, 1991; McCraw et al., 1991; Whittier et al., 1991). This increase in pelvic area is based on the theory that the estrogenic properties in the implant stimulate flat (pelvic) bone growth (Staigmiller et al., 1983). By 22 mo, no differences were found in pelvic area due to implanting at 2 mo of age in the present study. This is in agreement with Whittier et al. (1991).

The implant at 6 mo of age increased pelvic area ($P$ = .01) at 12, 18, and 22 mo (Table 1). Heifers implanted at 6 mo had an increase in pelvic area of 5 and 7 $cm^2$ at 12 and 22 mo of age, respectively. Because no interaction was found between implants, the combination of implants at 2 and 6 mo increased pelvic area the most.

External pelvic measurements were taken only on heifers in Trial 1. In general, the external measurements of width of hooks, width of pins, and hooks to pins were very similar among treatment groups at the various ages. Heifers implanted at either 2 or 6 mo had a slight increase in external measurements at 12 mo of age, but no significant differences were found at 22 mo.

*Reproductive Traits*

No interactions between implanting at 2 and 6 mo were observed; thus, the discussion centers on the effects of either the 2- or 6-mo implant.

Weight of ovaries and structures were obtained on the non-pregnant heifers in both trials. Implanting heifers at 2 mo increased ($P$ = .06) total ovarian weight and corpora lutea weight compared with no implanting at 2 mo. These results conflict with the theory that estrogenic properties in the implant inhibit LH secretions, which delay puberty and retard

Table 1. Least squares means and tests of treatment effects for growth measurements of heifers implanted with Synovex C® in the two trials

| | Treatment[b] | | | | | $P$-value[c] | |
|---|---|---|---|---|---|---|---|
| Item[a] | Control | 2 mo | 6 mo | 2 and 6 mo | SEM | 2 mo | 6 mo |
| No. of heifers | 94 | 94 | 93 | 88 | — | — | — |
| Heifers, wt, kg, at: | | | | | | | |
| 2 mo[d] | 82 | 82 | — | — | 1.1 | — | — |
| 6 mo[d] | 212 | 219 | — | — | 1.7 | .01 | — |
| 12 mo | 296 | 304 | 295 | 310 | 3.3 | .01 | — |
| 18 mo | 384 | 388 | 383 | 391 | 3.6 | .09 | — |
| 22 mo | 426 | 429 | 427 | 433 | 4.3 | — | — |
| Heifer gain, kg, for: | | | | | | | |
| 2 to 6 mo[d] | 130 | 137 | — | — | 1.0 | .01 | — |
| 6 to 12 mo | 84 | 85 | 82 | 90 | 1.8 | .01 | — |
| 12 to 18 mo | 88 | 84 | 89 | 82 | 1.4 | .01 | — |
| 18 to 22 mo | 41 | 39 | 39 | 39 | 1.4 | — | — |
| Hip height, cm, at: | | | | | | | |
| 6 mo[d] | 103.8 | 103.8 | — | — | .39 | — | — |
| 12 mo | 114.3 | 114.0 | 113.8 | 113.8 | .43 | — | — |
| 18 mo | 122.0 | 120.3 | 121.0 | 120.5 | .43 | — | .10 |
| 22 mo | 124.3 | 123.3 | 122.3 | 122.3 | .46 | .04 | .05 |
| Condition score[e] at: | | | | | | | |
| 12 mo | 5.4 | 5.6 | 5.4 | 5.6 | .05 | .01 | — |
| 18 mo | 5.7 | 5.8 | 5.8 | 5.8 | .04 | .05 | — |
| 22 mo | 5.2 | 5.4 | 5.3 | 5.5 | .05 | .01 | .04 |
| Udder score[f] at: | | | | | | | |
| 6 mo[d] | 1.2 | 1.6 | — | — | .03 | .01 | — |
| 9 mo | 1.1 | 1.5 | 1.4 | 1.7 | .05 | .01 | .01 |
| 12 mo | 1.9 | 2.1 | 2.2 | 2.3 | .06 | .01 | .01 |
| 18 mo | 1.4 | 1.4 | 1.6 | 1.5 | .07 | — | .01 |
| Calving | 1.8 | 1.8 | 1.9 | 2.0 | .08 | — | — |
| Pelvic area, $cm^2$, at: | | | | | | | |
| 6 mo[d] | 108 | 117 | — | — | .8 | .01 | — |
| 12 mo | 158 | 168 | 164 | 171 | 1.4 | .01 | .01 |
| 18 mo | 205 | 212 | 213 | 216 | 1.7 | .01 | .01 |
| 22 mo | 240 | 243 | 250 | 248 | 2.1 | — | .01 |

[a]Two months is at branding; 6 mo is at weaning; 9 mo is start of wintering; 12 mo is yearling; 18 mo is at pregnancy check, and 22 mo is precalving.

[b]Control = no implant; 2 mo = implanted at 2 mo; 6 mo = implanted at 6 mo; 2 and 6 mo = implanted at both 2 and 6 mo of age.

[c]Probability levels of treatment effects determined by orthogonal comparisons. Only values of .10 or less are reported. No 2- × 6-mo interactions were found.

[d]Control = all heifers in "Control" and "6 mo" groups; 2 mo = all heifers in "2 mo" and "2 and 6 mo" groups.

[e]Scoring system of 1 to 9, with 5 = moderate.

[f]Scoring system of 1 to 4, with 1 = normal development and 4 = extreme teat and udder development. At calving, scale was 1 to 3, with 1 = small udder and 3 = large udder.

growth of the reproductive tract (Moran et al., 1990). Cystic corpora lutea (vacuole in center) were found in 45% of the non-pregnant heifers, with no differences among treatments.

Reproductive traits of heifers by treatment group are presented in Table 2. Implanted heifers had a higher (2 mo. $P = .05$; 6 mo, $P = .01$) occurrence of non-puberal estrus (standing estrus without ovulation). However, no differences in date of puberty were noted among treatments. This is contrary to the belief that implanted heifers reach puberty later than control heifers.

No significant differences were found in the percentage of heifers reaching puberty before the start of breeding season. Whittier et al. (1991) reported a 10% increase in cycling activity before the start of the breeding season in heifers implanted at 2 to 3 mo of age, whereas McCraw et al. (1991) reported a slight decrease, compared with non-implanted heifers.

No significant differences were found among treatments in percentage of heifers in estrus first 21 d of breeding, first-service conception rate, and average conception date (Table 2). Rusk et al. (1992) showed a decrease in first-service conception rates for heifers implanted at 3 mo of age compared with controls. McCraw et al. (1991) reported no differences in first-service conception rates between heifers implanted at 2 mo of age and non-implanted heifers.

A trial effect ($P = .05$) was detected for non-puberal estrus, date of puberty, and percentage puberal before breeding season. Heifers in Trial 1 exhibited a higher percentage of non-puberal estrus activity than heifers in Trial 2. Heifers in Trial 2 reached puberty 24 d earlier than heifers in Trial 1. This later date of puberty for heifers in Trial 1 may be related to heifer weights at 12 mo of age. Heifers in Trial 2 were 26 kg heavier at yearling age than those in Trial 1. Arije and Wiltbank (1974) and Laster et al. (1972) have reported that heavier heifers reach puberty at a younger age. Also, a higher percentage of heifers was cycling before breeding in Trial 2 than in Trial 1 (91 vs 65%).

A trial × treatment interaction ($P = .05$) was found for the percentage of heifers pregnant in the first 21 and 63 d of breeding; therefore, data are reported separately for each trial (Table 2). No differences were found ($P > .10$) among treatments in Trial 1 for percentage of heifers pregnant in first 21 or 63 d of breeding. However, in Trial 2, implanting heifers at 6 mo decreased ($P = .05$) percentage of heifers pregnant in the first 21 d of breeding by 16% compared with control heifers (54 vs 70%). The 6-mo implant also decreased ($P = .05$) percentage of heifers pregnant in 63 d of breeding by 10%.

Whittier et al. (1991) results showed a small reduction in yearling pregnancy rate due to the

Table 2. Treatment means and tests of treatment means for reproductive measurements of heifers implanted with Synovex C® in the two trials

| Item[a] | Treatment[b] | | | | P-value[c] | |
|---|---|---|---|---|---|---|
| | Control | 2 mo | 6 mo | 2 and 6 mo | 2 mo | 6 mo |
| No. of heifers | 94 | 94 | 93 | 88 | — | — |
| Non-puberal estrus, % | 8 | 19 | 23 | 40 | .05 | .01 |
| | (5,14) | (12,28) | (16,33) | (29,51) | | |
| Date of puberty | 3/14 | 3/13 | 3/15 | 3/13 | — | — |
| Puberal before breeding season, % | 83 | 84 | 77 | 78 | — | — |
| | (70,91) | (71,92) | (62,87) | (64,88) | | |
| In estrus first 21 d of breeding, % | 92 | 89 | 89 | 89 | — | — |
| | (82,97) | (77,95) | (78,95) | (77,95) | | |
| First-service conception, % | 68 | 65 | 57 | 61 | — | — |
| | (57,78) | (52,75) | (45,68) | (48,72) | | |
| Conception date | 6/7 | 6/9 | 6/9 | 6/9 | — | — |
| Pregnancy in breeding season[d] | | | | | | |
| First 21 d, % | | | | | | |
| Trial 1 | 65 | 51 | 62 | 62 | — | — |
| Trial 2 | 70 | 70 | 60 | 48 | — | .05 |
| Total 63 d, % | | | | | | |
| Trial 1 | 93 | 83 | 87 | 93 | — | — |
| Trial 2 | 94 | 100 | 92 | 83 | — | .05 |

[a]Percentage data pooled over trials were transformed to logits, analyzed by weighted least squares, then the least squares means of logits were transformed back to percentages for presentation; value in ( ) beneath these means are limits for 95% confidence intervals. Date data were analyzed by least squares and presented here as calendar day; no standard errors are given due to the method of presentation and because there were no differences.

[b]See Table 1 for description of treatments.

[c]Probability levels of treatment effects determined by orthogonal comparisons. Only values of .10 or less are reported. No 2- × 6-mo interactions were found.

[d]A trial × treatment interaction existed.

2-mo implant. Rusk et al. (1992) reported a larger decrease in yearling pregnancy rates due to implants at either 3 mo or at both 3 and 6 mo of age. Their results may be due to a lower percentage of implanted heifers cycling before the start of breeding and lower yearling heifer weights.

Heifers implanted at both 2 and 6 mo had a final pregnancy rate similar to control heifers in Trial 1 but a lower pregnancy rate (11%) than that of control heifers in Trial 2. The reason for these results is not known. Research on Ralgro® has shown that multiple implants given to replacement heifers can lower fertility as in Trial 2 (Staigmiller et al., 1983; Deutscher et al., 1986; Moran et al., 1990). Pregnancy rates in a 63-d breeding season for the control heifers were similar for Trial 1 (93%) and Trial 2 (94%).

*Calving Traits*

Table 3 shows the combined calving traits for both trials by treatment group. No differences ($P > .10$) were found between treatments in date of calving. An interaction ($P = .01$) occurred between the 2- and 6-mo implants for calf birth weight. Heifers receiving implants at both 2 and 6 mo had calves with the lightest birth weights. This combination of implants may have caused the uteri of these heifers to be slightly smaller, which decreased calf birth weight. This theory is supported by the results from Moran et al. (1990), who reported that 15-mo heifer uterine weights were heavier for heifers that were not implanted than heifers that were implanted multiple times with Ralgro® (141.3 vs 102.8 g). No differences ($P > .10$) among treatments were found in gestation length for calves from AI, which indicates differences in calf birth weights were not caused by gestation length.

Implants at either 2 or 6 mo decreased ($P = .01$) calving difficulty scores. Heifers implanted at both 2 and 6 mo had the lowest calving difficulty score. These heifers had only 14% calving difficulty compared with 32% of the heifers in the non-implanted group. McCraw et al. (1991) and Rusk et al. (1992) showed no reduction in calving difficulty, whereas Whittier et al. (1991) showed a small reduction when heifers were implanted at 2 to 3 mo of age. The implant at 2 mo caused a slightly better ($P = .01$) calf vigor score, which may have been due to less calving difficulty.

Heifers implanted at both 2 and 6 mo had the highest pelvic area:calf birth weight ratios (Table 3). These heifers had large precalving pelvic areas and small birth weight calves and had the least amount of calving difficulty. Previous research has shown that the larger ratio is related to a lower degree of calving difficulty (Johnson et al., 1988).

*Traits of Two-Year-Old Cows*

Table 4 shows the reproduction and production traits of 246 2-yr-old cows from Trials 1 and 2. No differences ($P > .10$) were found in total pregnancy rates among treatments. However, in both trials, the control cows had the lowest pregnancy rates and the cows that were implanted only at 6 mo of age had the highest pregnancy rates. No differences were found in milk production or first-calf weaning weights, indicating no long-term effects of the implants on milk production.

Growth measurements on the cows at 35 mo of age (before second calving season) and second calving

Table 3. Treatment means and tests of treatment means for measurements at first calving of heifers implanted with Synovex C® in the two trials

| | Treatment[b] | | | | | P-value[c] | | |
|---|---|---|---|---|---|---|---|---|
| Item[a] | Control | 2 mo | 6 mo | 2 and 6 mo | SEM | 2 mo | 6 mo | Interaction |
| No. of heifers | 79 | 82 | 76 | 73 | — | — | — | — |
| Calving date | 3/13 | 3/14 | 3/15 | 3/15 | — | — | — | — |
| Calf birth wt, kg[d] | 33.3 | 33.6 | 34.9 | 32.4 | .45 | .09 | — | .01 |
| Gestation length for calves sired by AI, d[d] | 279 | 279 | 279 | 279 | — | — | — | — |
| Calf vigor score[de] | 2.7 | 2.6 | 2.9 | 2.5 | .09 | .01 | — | — |
| Calving difficulty score[df] | 1.84 | 1.65 | 1.62 | 1.30 | .11 | .01 | .01 | — |
| Calving difficulty, %[g] | 32 (25,39) | 29 (22,36) | 23 (17,30) | 14 (10,19) | — | — | — | — |
| Pelvic area:birth wt ratio[h] | 7.33 | 7.33 | 7.37 | 7.74 | .02 | .08 | .03 | .08 |

[a]Least squares means for most measurements, but see footnote a in Table 2 for explanation of analyses of percentage data and date data.
[b]See Table 1 for description of treatments.
[c]Probability levels of treatment effects determined by orthogonal comparisons. Only values of .10 or less are reported.
[d]Trait analyzed removing effects of calf sex and sire.
[e]Scoring system was 1 to 5, with 1 = nursed within 30 min; 4 = did not nurse within 75 min and was assisted; 5 = dead at birth.
[f]Scoring system was 1 to 5, with 1 = no assistance and 5 = C section; all abnormal presentations were deleted from analysis.
[g]Includes only scores 3, 4, and 5.
[h]Ratio is pelvic area before calving divided by calf birth weight.

Table 4. Treatment means and tests of treatment means for reproductive, growth, and calving measurements of young cows, implanted with Synovex C® as calves in the two trials

| Item[a] | Treatment[b] | | | | SEM | P-value[c] | |
|---|---|---|---|---|---|---|---|
| | Control | 2 mo | 6 mo | 2 and 6 mo | | 2 mo | 6 mo |
| No. of animals | 60 | 63 | 61 | 62 | — | — | — |
| Reproduction and production of 2-yr-old cows | | | | | | | |
| Pregnancy in 60-d breeding season, % | 80.0 | 90.5 | 93.4 | 85.5 | — | — | — |
| Daily milk production, kg[d] | 5.4 | 5.0 | 5.6 | 5.5 | .86 | — | — |
| Calf weaning wt, kg[e] | 193 | 195 | 192 | 191 | 6.8 | — | — |
| Growth measures at 35 mo[f] | | | | | | | |
| No. of cows | 48 | 56 | 57 | 52 | — | — | — |
| Pelvic area, $cm^2$ | 296 | 301 | 302 | 297 | 2.9 | — | — |
| Cow wt, kg | 487 | 493 | 489 | 485 | 13.0 | — | — |
| Cow body condition score | 5.2 | 5.2 | 5.2 | 5.3 | .05 | — | — |
| Second calving measures | | | | | | | |
| Calving date[g] | 3/20 | 3/22 | 3/20 | 3/17 | 1.6 | — | — |
| Calf birth wt, kg[g] | 38.5 | 39.8 | 40.0 | 38.6 | 1.2 | — | — |
| Calving difficulty score[gh] | 1.1 | 1.1 | 1.2 | 1.2 | .1 | — | — |
| Calving difficulty, %[i] | 4 | 5 | 5 | 8 | — | — | — |

[a]Percentage data analyzed by chi-square analysis, other data by least squares.
[b]See Table 1 for description of treatments.
[c]Probability levels of treatment effects determined by orthogonal comparisons. Only values of .10 or less are reported. No 2- × 6-mo interactions were found.
[d]Average of 2 or 3 measurements in each trial.
[e]Weaning weights adjusted for sex and sire.
[f]Measures at 35 mo of age are before second calving.
[g]Trait analyzed removing effects of calf sex.
[h]Scoring system was 1 to 5, with 1 = no assistance and 5 = C section.
[i]Includes only scores 3, 4, and 5.

measures are shown in Table 4. No differences ($P > .10$) were found in pelvic area, cow weight, or body condition score at 35 mo of age among treatments. Also, no differences ($P > .10$) were found among treatments in second-calf birth date, birth weight, and percentage of calving difficulty. Therefore, no long-term negative effects on cow size or calf production were observed for the Synovex C® implants.

## Implications

Results indicate that cow/calf producers can use suckling Synovex C® implants at 2 mo of age to increase weaning weights without causing significant detrimental effects on the fertility of heifers retained for breeding purposes. Implants can also be incorporated into the producer's management system to help decrease calving difficulty in replacement heifers. If multiple implants are used, additional heifers may need to be saved for replacements to compensate for possible lower pregnancy rates.

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