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CHANGES IN PELVIC CONFORMATION AND PERIPHERAL ESTRONE CONCENTRATIONS IN PRE- AND POST-PARTUM BEEF COWS[1]

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ABSTRACT

An experiment was conducted to investigate the temporal relationship of peripheral estrone (E_1) concentration to changes in the size of the pelvic opening preceding and immediately following parturition Twenty-six multiparous beef cows were observed from approximately 50 d prepartum to 7 d postpartum Blood samples were collected at 7 d intervals preceding calving and at 1, 3 and 7 d following for E_1 quantitation Estimates of pelvic opening area were made at the time of blood sampling Peripheral E_1 concentrations were elevated beginning at approximately 25 d prepartum Dams bearing male fetuses had greater ($P<0.01$) concentrations of E_1 than did dams with female fetuses Calf birth weight was correlated ($r = 0.44$, $P<0.01$) with E_1 levels from 10 d prepartum through parturition Postpartum pelvic area was greater for cows giving birth to male calves, with no significant differences for calf birth weights by sex Correlations were observed between E_1 concentration, and pelvic area measured from 50 d prepartum to 7 d postpartum ($r = 0.26$, $P<0.01$), 10 d prepartum to calving ($r = 0.42$, $P<0.01$), and from calving to 7 d postpartum ($r = 0.33$, $P<0.01$) Percentage increase in E_1 concentration from 50 d prepartum to calving was significantly correlated ($r = 0.75$, $P<0.01$) to percentage pelvic area increase over the same period A correlation also exists between maternal E_1 concentrations and fetal sex and pelvic area In summary, the increased estrogen concentrations in cows with male calves may facilitate pelvic spread, resulting in a larger pelvic opening

INTRODUCTION

A dramatic increase in the concentration of circulating estrogens occurs just prior to parturition in the bovine (1, 2, and 3) It is evident since the first report of Pope et al (4) that the predominant estrogen during this prepartum rise is estrone (E_1) Paralleling this rise in serum E_1 is the enlargement of the pelvic opening in preparation for calving, as documented by Rice and Wiltbank (5), Ward (6) and Laster (7) Although these workers indicated that smaller prepartum pelvic area measurements are significantly associated with incidence of dystocia, these measurements alone were not adequate indicators of impending calving difficulties. The present study was executed to determine if peripheral E_1 concentration might serve as a quantitative indicator of peripartum changes in pelvic area and elucidate the relationship between fetal sex, E_1 concentration and pre- and postpartum pelvic area changes

MATERIALS AND METHODS

Twenty-six English crossbred multiparous cows in good condition (511 ± 20 kg, $\bar{x}$ ± SE) and in the latter one-third of gestation were randomly selected

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and maintained on fescue/clover pastures Cows were mated naturally, in the Fall, to Red Poll bulls, and produced the calves referred to in this study The experimental period extended from early September to late October Blood samples were collected from all cows by jugular venipuncture at 7 d intervals beginning on September 14 until calving Following calving, each cow was bled on d 1, 3 and 7 postpartum Blood was allowed to clot in untreated glass collection vials at ambient temperature, then centrifuged at 1000 × g for 20 min Serum was stored at −20 C Cattle were weighed at the time of bleeding, and pelvic measurements were made using a Rice Pelvimeter[4] Two estimations were taken rectally on each occasion, a vertical measurement extending from symphysis pubis to sacral vertebrae and a horizontal measurement linking the shaft of one ilium to the other at the level of the psoas tubercles The product of the horizontal and vertical distances was expressed in square centimeters (cm^2) Calf weights and sex were recorded within 12 hr of birth Statistical analysis of results included analysis of variance of the general linear model, determination of correlation for data measured over time (8), and student's t-test procedures for variables measured in respect to sex

Radioimmunoassay Validation:

Unconjugated E_1 was measured by the method of England et al (9) using duplicate 0 5 ml serum samples which were extracted with 4 volumes of benzene E_1 recovery was determined by the addition of labeled E_1 prior to extraction, and final E_1 concentration in unknown samples was corrected accordingly Iodinated tyrosine methyl ester of E_1 was prepared by the method of Bajpai et al (10) The radioimmunoassay procedure was validated by extracting differing amounts of pooled cow serum (Table 1) and by quantitative recovery experiments (Table 2) Twenty serum extracts were assayed for E_1 directly ($\bar{x}$= 1 59 ng/mg) The same samples were purified by Sephadex (LH-20)[5] column chromatography and yielded similar E_1 concentrations ($\bar{x}$ = 1 51 ng/ml) Mean E_1 concentrations of both chromatographed and non-chromatographed extracts varied by no more than 5% from the overall mean of extracts assayed Assay sensitivity was 0 02 ng/ml, as defined by that concentration of E_1 necessary to cause a 10% decrease in binding from a standard containing no E_1 Antibody cross reactivity with estriol, 17-α and 17-β estradiol was less than 1% and is shown in Figure 1 Pooled bovine serum samples analyzed at each radioimmunoassay produced inter- and intra-assay coefficients of variation of 9 1 and 3 7%, respectively

RESULTS

Peripheral E_1 concentrations were significantly ($P<0\ 01$) greater for cows bearing male fetuses (n = 11) than for those with female fetuses (n = 15), for periods extending from −50 d to calving (Table 3) No significant differences in maternal E_1 concentrations occurred postpartum Prepartum pelvic area was

TABLE 1 SERUM ESTRONE BY CONCENTRATION (ng/ml) FOLLOWING THE EXTRACTION OF VARIOUS VOLUMES OF POOLED COW SERUM

Pooled Cow Serum Extracted (ml)	Estrone[1]	SE[2]
0 5[3]	0 521	0 040
1 0	0 547	0 048
1 5	0 501	0 051
2 0	0 480	0 082

[1]Each mean is the result of 4 determinations
[2]Standard error of the mean
[3]Extraction volume chosen for use in assay

TABLE 2 RECOVERY OF ESTRONE (ng/ml) FROM STEER SERUM AND IN STEER SERUM PLUS KNOWN AMOUNTS OF EXOGENOUS ESTRONE

Estrone Added	Estrone[2] Measured	SE[3]
0 00	0 014	0 009
0 01	0 016	0 013
0 10	0 124	0 017
0 25	0 364	0 067
0 50	0 668	0 045
1 00	1 202	0 033
10 00	10 825	0 141

[1]0 5 ml serum extracted
[2]Each mean is the result of 4 determinations
[3]Standard error of the mean

not influenced by fetal sex However, the postpartum pelvic area for cows that gave birth to male calves was significantly ($P<0.01$) greater than for those that gave birth to females There was no effect of sex on calf birth weight All cows calved unassisted Significant correlations occurred between E_1 and pelvic area measured from 50 d prepartum to 7 d postpartum ($r = 0.26$, $P<0.01$), from 10 d prepartum to calving ($r = 0.42$, $P<0.01$), and from calving to 7 d postpartum ($r = 0.33$, $P<0.01$) Calf birth weight was correlated ($r=0.44$, $P<0.01$) with maternal E_1 concentration measured from 10d prepartum to calving Total percentage increase in E_1 concentration measured from 50 d prepartum to calving was correlated ($r =0.75$, $P<0.01$) with percentage pelvic area change

DISCUSSION

Both the timing of the prepartum E_1 surge and the concentrations involved agree with others (1,2,3) The present study also confirms the observation of Erb et al (11) associating calf weight with maternal E_1 levels, as calf weight was correlated with the maternal E_1 concentration measured during the 10 d immediately preceding parturition Larger placentas that are associated with

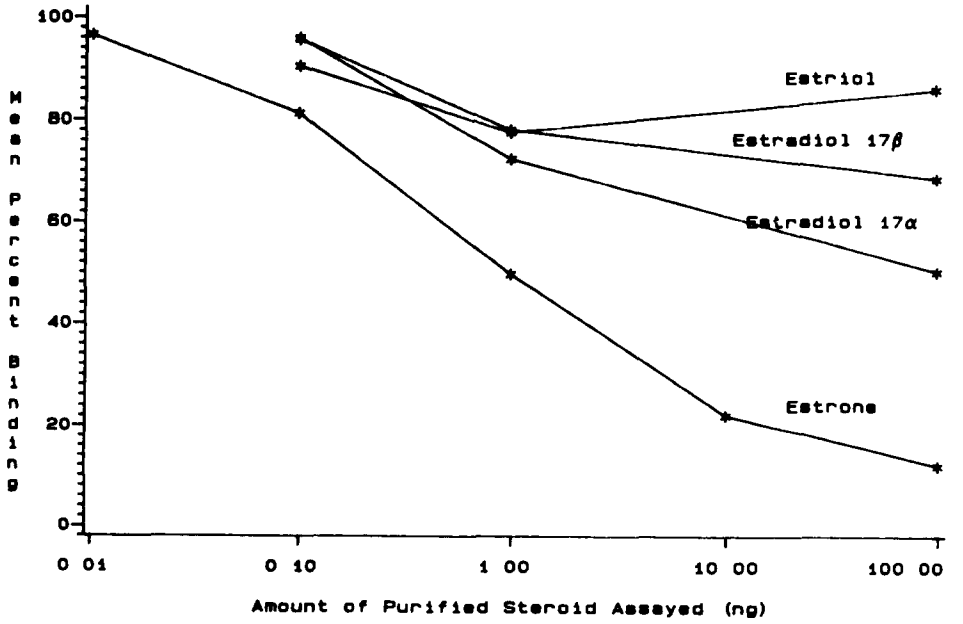

Fig 1 Cross reactivity of estrone antibody with similar estrogens

TABLE 3 MATERNAL SERUM ESTRONE CONCENTRATIONS (ng/ml), PELVIC AREA (cm²) AND CALF BIRTH WEIGHT (kg)

	Pooled	Cows with female fetuses	Cows with male fetuses
Variable[a]	$\bar{x} \pm SE$[b]	$\bar{x} \pm SE$	$\bar{x} \pm SE$
E_1, d −50 to 7	1 07±0 10	0 99±0 12	1 20±0 2
E_1, d −50 to −21	0 50±0 01	0 43±0 18[c]	0 62±0 2[d]
E_1, d −20 to −11	1 36±0 05	1 22±0 07[c]	1 55±0 1[d]
E_1, d −10 to 0	3 65±0 11	3 36±0 14[c]	4 07±0 1[d]
E_1, d 0 to 7	0 36±0 01	0 36±0 01	0 36±0 0
PA, d −50 to 7	187 2 ±1 6	185 9 ±1 8	189 6 ±3 0
PA, d −50 to −21	171 6 ±1 7	171 6 ±2 3	171 7 ±2 3
PA, d −20 to −11	184 3 ±1 5	182 0 ±1 8	187 5 ±2 5
PA, d −10 to 0	200 0 ±1 9	200 0 ±2 0	200 1 ±3 6
PA, d 0 to 7	181 5 ±1 3	177 9 ±1 6[c]	187 6 ±2 1[d]
Birth Weight	—	32 9 ±0 6	34 3 ±0 8

[a]Estrone (E_1) concentration and pelvic area (PA) measured from 50 days prepartum (d −50) to 7 days postpartum (d 7) and at parturition (d 0)
[b]Standard error of the mean
[c]Within a row, means bearing different superscripts are significantly different ($P<0.01$)

larger fetuses (12) may account for differences in maternal serum estrogens The origin of the major portion of maternal estrone associated with the prepartum surge was previously reported by Hoffman et al (13) to be placental Although placental estrogens may be produced *de novo*, the bovine placenta is fully capable of converting fetal androstenedione (C_{19}) and pregnenolone (C_{21}) precursors into estrogens (14) Chew et al (15) reported that the concentration of serum estrogens was higher in cows carrying male calves This difference was most noticeable during the last 18 d of pregnancy As in the present study, the researchers did not observe a difference in calf birth weight by sex In addition, they reported a positive correlation between calf birth weight and E_1, estradiol 17-β and total estrogens These reports, together with our findings, indicate that cows carrying male calves produce more E_1 than cows with female calves The increase in serum E_1 concentration in cows with male calves may be due to an increase in fetal/placental weight affecting estrogen production, decreased peripheral metabolism, or other factors In this regard, it was suggested by Chew et el (15) that male calves may be more active *in utero* and consequently stimulate the placenta to produce more estrogen Maternal testosterone concentrations in early human pregnancy are significantly higher in mothers carrying male fetuses than in those with female fetuses (16) It may be postulated, therefore, that a similar increase in androgens during bovine pregnancy could account for increased placental estrogen production due to an enhanced availability of aromatizable androgen precursor

In the present study, rising maternal E_1 levels are associated with increased pelvic area Prepartum pelvic area measurements were not different, however, pelvic measurements taken postpartum were greater in cows that gave birth to male calves Estrogens have been shown to stimulate relaxin production (17) which may result in changes in the symphysis pubis However, a recent report (18) suggests that relaxin can increase circulating estrogens during late gestation in this species Relaxin converts the symphysis pubis from a compact, cartilaginous connective tissue to a more fluid flexible form (19) and synergizes with estrogen to cause a selective erosion of the pubic bones (20) The data suggest that elevated maternal E_1 levels in cows delivering male calves may facilitate a loosening of the pelvic ligaments that is reflected in a larger pelvic area opening post-calving

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[4]Lane Manufacturing Inc , 2057 S Hudson, Denver, CO, 80222 Use of this product does not constitute endorsement by the University of Arkansas Department of Animal Sciences
[5]Sephadex, LH-20, Pharmacia Fine Chemicals Inc , Centennial Avenue, Piscataway, NJ, 08854

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