2016

Cows with Excess Androgen are Anovulatory and Have Differing Patterns of Progesterone Secretion

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Summary

Within the physiology herd, a group of cows that have excess androgen (androstenedione, A4) in the dominant follicle and a 17% reduction in calving rate have being identified. Thus, our objective was to determine follicular dynamics (follicle growth) and progesterone (P4) concentrations in High A4 cows to determine if they were anovulatory. High A4 cows had more persistent dominant follicles and either did not display estrus and ovulated at an inappropriate time or did not ovulate compared with Low A4 cows (Controls). Furthermore, P4 concentrations had reduced peak values and were maintained longer in High vs Low A4 cows which may contribute to their failure to ovulate.

Introduction

A major reason a cow is removed from the herd is the failure to have a calf. Within the UNL physiology herd there is a population of females, which have reduced calving rate and is associated with increases in excess androgen in the dominant follicle.

In cattle, ovarian follicles develop in a wave-like pattern referred to as follicular waves. After ovulation of the dominant follicle, a new wave is initiated with the recruitment of small follicles. A follicle is subsequently either selected to become a dominant follicle or undergoes atresia allowing for 2 or 3 follicular waves during a cow estrous cycle which on average is 21 d. Furthermore, the selected follicle which will become the dominant follicle inhibits the growth of the other small follicles. What triggers this follicle to ovulate is the drop in P4 and increases in estrogen to stimulate surges of gonadotropin hormones such as Luteinizing Hormone (LH) and Follicle Stimulating Hormone (FSH). If P4 does not drop to levels, which will allow for increases in estrogen and concomitant increases in LH and FSH, then ovulation will not occur and the follicle remaining on the ovary may become a persistent follicle. Many persistent follicles can produce excess androgen and because no ovulation occurred no corpus luteum (CL) is produced. Without the CL to regress, P4 concentrations do not change and this can affect the initiation of the next reproductive cycle. In some cases the persistent follicle luteinizes producing small amounts of P4 which may aid in the start of a new estrous cycle after it is no longer present on the ovary.

Since many cattle producers use standing heat (estrus) as a marker for when to AI their females; estrus without ovulation, ovulation without a previous standing heat or estrus, or no estrus or ovulation could impact the number of females identified to breed. In turn, this could reduce the number that get pregnant, reducing the calf crop and producer profitability.

Excess androgen has been demonstrated to affect the ability of females to ovulate; so our objectives with this experiment were to determine (1) if the cows identified as High A4 were also anovulatory (failed to ovulate), (2) if High A4 cows fail to display estrus, and (3) if ovulation occurred every time estrus was displayed.

Procedure

All procedures were approved by the Animal Care and Use Committee at the University of Nebraska-Lincoln. Non-

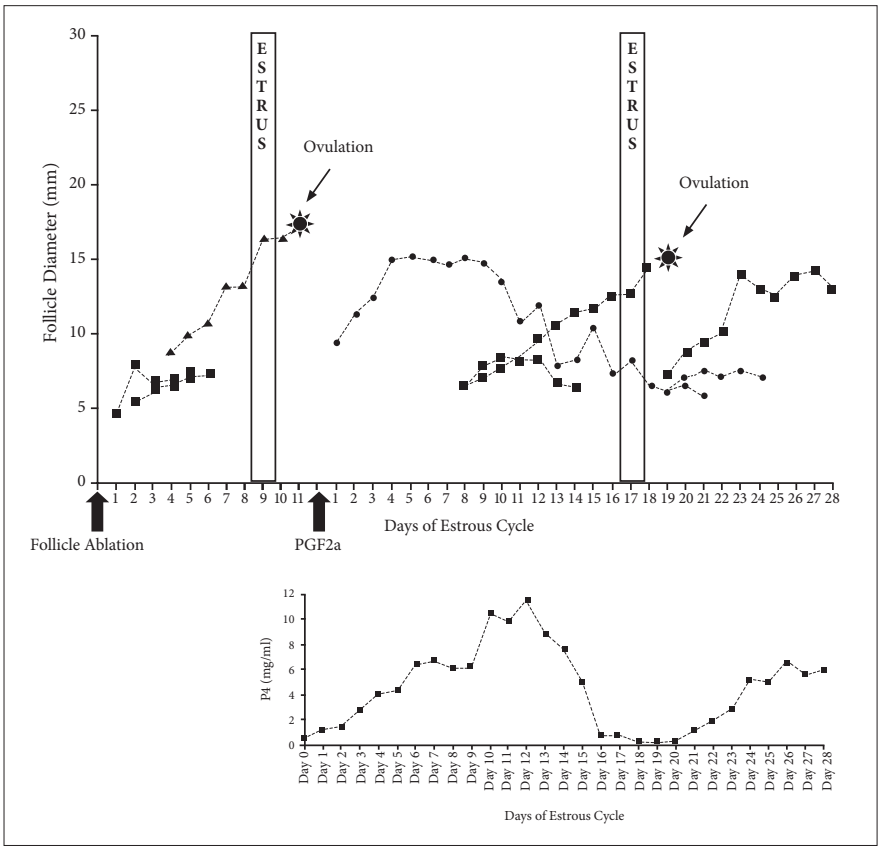

Figure 1. Diagram of follicular waves, d of ovulation and estrus after follicle ablation for Low A4 cow (ovulatory; upper diagram). Graph below shows progesterone concentrations measured daily after PGF_{2a} injection.

lactating, composite (25% MARC III [1/4 Angus, 1/4 Hereford, 1/4 Pinzgauer, 1/4 Red Poll] and 75% Red Angus) beef cows from the beef physiology herd at the University of Nebraska Agricultural Research and Development Center (ARDC), near Mead, were used in this study.

Each cow with a follicle(s) greater than 7 mm was ablated (aspirated) using a vaginal ultrasound probe with a needle to puncture the follicle and remove it from the ovary. Twelve days after the follicle ablation cows were injected with 5ml of $PGF_{2\alpha}$. Transrectal ultrasound was conducted daily with a 7mm Aloka probe starting at initial follicle ablation and was continued for 28 d. Ovulation was determined by the absence of the preovulatory follicle. Estrus was detected using Estrotec™ Heat Detector placed to their tail head. Blood samples were collected daily and P4 concentrations from blood samples were measured every day after $PGF_{2\alpha}$ treatment and are shown in Figures 1, 2 and 3.

The concentration of A4 in follicular fluid of the dominant follicle was used to classify cows into Low A4 (n = 5, control; A4 where A4 less than 20 ng/ml), and High A4 (n = 6, excess A4 where A4 greater than 40 ng/ml).

Results

Different ovulatory phenotypes were found between Low A4 and High A4 cows (Figure 1, 2, 3). Low A4 cows (ovulatory) displayed estrus and ovulated directly after estrus occurred. The day of estrus was considered when an Estrotec™ Heat Detector patch had more than 75% of its area rubbed-off. Low A4 cows also had typical P4 concentrations with a peak around d12 of the estrous cycle followed by a decrease immediately before estrus display and ovulation occurred (Figure 1). High A4 cows presented 2 different phenotypes: chronic anovulatory or cows displaying estrus, but failed to ovulate (persistent dominant follicle was present in the ovary for at least 10 d) and produced very low amounts of P4 during the entire 28 d (Figure 2); and sporadic anovulatory or cows not displaying estrus, but did ovulate during the 28 d and had greater P4 values than chronic anovulatory cows (Figure 3).

Additionally, the pattern of P4 secretion was different in High A4 cows with a

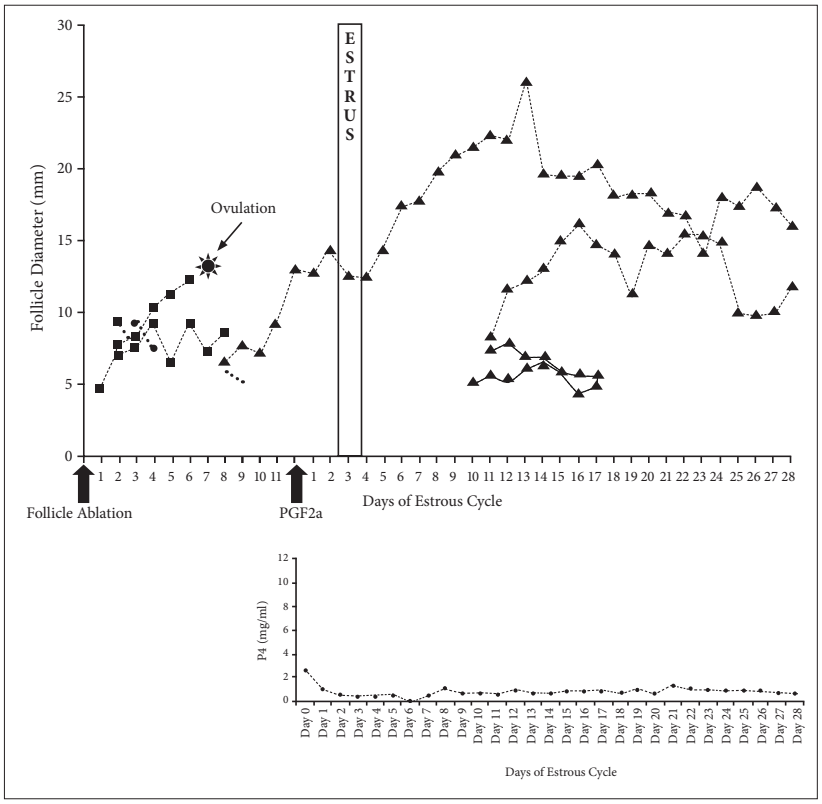

Figure 2. Diagram of follicular waves, and estrus in a High A4 cow who was classified as chronic anovulatory since estrus was detected but there was no ovulation of the dominant follicle (upper diagram), and very low progesterone concentrations since no corpora lutea was produced (graph below).

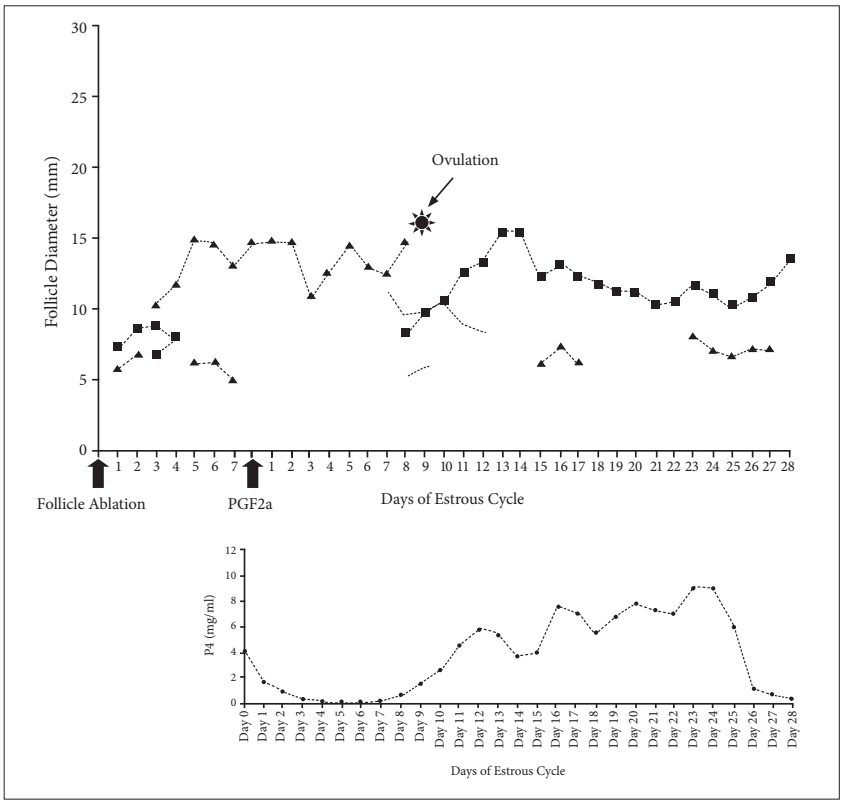

Figure 3. Follicular waves and the d of ovulation characterizing a High A4 cow who was classified as sporadic anovulatory is showed in the upper diagram, no estrus or ovulation was detected, as well as the progesterone values (graph below).

40% decrease in peak value (5.83 ng/mL) compared with to Low A4 cows (8.18 ng/mL). Furthermore, P4 in High A4 cows remained greater than 3.0 ng/ml during the time CL regression was occurring while Low A4 cows' P4 concentrations dropped at CL regression to less than 1.5 ng/ml.

Reduced peak P4 concentrations with sustained levels of P4 over a longer period of time in High A4 cows may contribute to their inability to ovulate. In addition, these differences in P4 production and maintenance may indicate granulosa and theca cells within the dominant follicle that support the egg are altered and may not be capable of producing a fully functional CL (similar to a sub-functional CL). Understanding what is different about these cows and what is impacting their ability to ovulate may lead to more efficient synchronization regimes to induce cows to display estrus and ovulate at appropriate times or ovulate at all. Alternatively, methods may be developed to identify these females to ensure they are not kept as replacement females.

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