Theriogenology 83 (2015) 822–831

Contents lists available at ScienceDirect

Theriogenology

journal homepage: www.theriojournal.com

Effect of vaccination with a multivalent modified-live viral vaccine on reproductive performance in synchronized beef heifers

Paul H. Walz [a,*], Misty A. Edmondson [b], Kay P. Riddell [a], Timothy D. Braden [c], Julie A. Gard [b], Jenna Bayne [b], Kellye S. Joiner [a], Patricia K. Galik [a], Sjoert Zuidhof [d], M. Daniel Givens [a]

[a] Department of Pathobiology, College of Veterinary Medicine, Auburn University, Auburn, Alabama, USA
[b] Department of Clinical Sciences, College of Veterinary Medicine, Auburn University, Auburn, Alabama, USA
[c] Department of Anatomy, Physiology, and Pharmacology, College of Veterinary Medicine, Auburn University, Auburn, Alabama, USA
[d] Boehringer Ingelheim Vetmedica, Inc., St. Joseph, Missouri, USA

ARTICLE INFO

Article history:
Received 25 August 2014
Received in revised form 14 November 2014
Accepted 16 November 2014

Keywords:
Bovine herpesvirus 1 (BoHV-1)
Bovine viral diarrhea virus (BVDV)
Vaccination
Conception
Progesterone
Estrous cycle

ABSTRACT

Prebreeding vaccination should provide fetal and abortive protection against bovine viral diarrhea virus (BVDV) and bovine herpesvirus 1 (BoHV-1) but not impede reproduction when administered to cattle before estrus synchronization and breeding. The objective was to assess reproductive performance when naive beef heifers were vaccinated with modified-live viral (MLV) vaccine 2 days after unsynchronized estrus, and then revaccinated with MLV vaccine at 10 or 31 days before synchronized natural breeding. Sixty beef heifers naive to BVDV and BoHV-1 were randomly assigned to one of four treatment groups. Groups A and B (n = 20 per group) were vaccinated with MLV vaccine containing BVDV and BoHV-1 at 2 days after initial detected estrus, and then revaccinated 30 days later, which corresponded to 10 days (group A) or 31 days (group B) before synchronized natural breeding. Groups C and D (n = 10 per group) served as controls and were vaccinated with an inactivated vaccine that did not contain BVDV or BoHV-1 at the same time points as groups A and B, respectively. Estrous behavior was assessed using radio frequency technology. Estrus synchronization was performed, with initiation occurring at revaccination (groups A and C) or 21 days after revaccination (groups B and D). After synchronization, heifers were submitted to a bull breeding pasture for 45 days. At the end of the breeding period, heifers were assessed for pregnancy using ultrasonography. Progesterone concentrations were evaluated at estrus and 10 days after unsynchronized and synchronized estrus, at initial pregnancy check, and at the end of the study. All pregnant heifers in groups A and B and five pregnant heifers in group C were euthanized between 44 and 62 days of gestation and ovarian and conceptus tissues were assayed for BVDV and BoHV-1. Vaccination with MLV vaccine did not result in significant negative reproductive impact based on the duration of interestrus intervals, proportion of heifers exhibiting estrus within 5 days after synchronization, serum progesterone concentrations, pregnancy rates, and pregnancies in the first 5 days of the breeding season. Bovine viral diarrhea virus and BoHV-1 were not detected in luteal tissue, ovarian tissue, or fetal tissues. Use of MLV vaccine did not impede reproduction, when revaccination was performed at 10 or 31 days before synchronized natural breeding.

* Corresponding author. Tel.: +1 334 844 4951; fax: +1 334 844 4955.
E-mail address: walzpau@auburn.edu (P.H. Walz).

0093-691X/$ – see front matter © 2015 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.theriogenology.2014.11.015

1. Introduction

Bovine viral diarrhea virus (BVDV) and *bovine herpesvirus 1* (BoHV-1) are important pathogens of the reproductive tract, resulting in infertility, abortions, and birth of calves with poor health [1]. These pathogens and the diseases they cause affect cattle herds worldwide, thus impacting reproductive and overall efficiency of the global cattle industry. Enhancing immunity through vaccination provides an important contribution to limiting reproductive losses associated with these viral infections and is also an important control procedure to limit transmission of BVDV and BoHV-1 among cattle populations. Modified-live viral (MLV) or killed viral (KV) vaccines are available for BVDV and BoHV-1, often in multivalent formulations.

Because MLV BVDV and BoHV-1 vaccines were introduced, concern has been expressed regarding the safety of these multivalent vaccines on female reproduction, with most concern focused on the BoHV-1 fractions of the MLV vaccines causing abortions when given to pregnant cattle [2]. Although prebreeding administration of MLV vaccines has been found to provide optimal fetal protection against the negative reproductive effects of BVDV and BoHV-1 [3–5], initial administration to naive animals within several weeks of breeding may result in diminished reproductive performance of beef heifers and cows [6–9]. Vaccination of naive heifers with MLV vaccines at the onset of standing estrus has been found to have negative effects on the function of the CL [7,8]. If prebreeding vaccination with MLV BoHV-1 results in a subsequent viremia that coincides with the development of the CL after ovulation, severe necrotizing lesions develop in the CL [10,11]. If prebreeding vaccination results in a subsequent viremia, which coincides with the mid-luteal phase, then resulting ovarian lesions include only a few small necrotic foci within the CL [10]. Severe necrotizing lesions within the CL have been associated with decreased circulating concentrations of progesterone (P4), prolonged interestrus intervals, and a subsequent, transient subfertility. Timing of BoHV-1 viremia within the stage of the estrous cycle is a critical determinant to negative effects on estrous cyclicity and fertility.

Efficient reproduction is important for optimal profitability on beef operations. Estrus synchronization, ovulation synchronization, and artificial insemination (AI) are reproductive management tools available to beef producers, and these tools have the potential to shorten the calving season, increase calf uniformity, and facilitate the use of AI, thereby increasing beef producer profitability [12]. As the label on most MLV vaccines containing BoHV-1 and BVDV indicates that administration should be at or about 4 weeks before breeding, a focused, intensive, conscientious beef producer is likely to vaccinate heifers at 28 days before a planned AI date. If an applied estrus synchronization protocol involves synchrony of a previous estrus in a naive beef heifer, then ovarian lesions could be maximized because of the timing of vaccination occurring immediately before or within the synchronization of estrus. As a result, subsequent interestrus intervals may be prolonged and fertility at AI could be compromised. In a recent report, effects of vaccination on reproductive hormone concentrations and pregnancy rates were evaluated when initial vaccination was performed in naive crossbred beef heifers at the time of estrus synchronization and 8 days before timed AI [9]. Pregnancy rates were reportedly greater in unvaccinated heifers and heifers vaccinated or revaccinated with KV vaccines compared with heifers receiving their initial MLV vaccine [9]. Furthermore, heifers given the MLV vaccine had a greater percentage of abnormal estrous cycles when compared with the unvaccinated and KV vaccinated groups. Key features of that study were the use of naive beef heifers and off-label administration of vaccine in two treatment groups. Other studies have evaluated the effect of vaccination on fertility in which heifers possessed immunity to BoHV-1 and BVDV acquired through previous vaccination [13,14]. No difference in pregnancy rates was observed when revaccination was administered at the time of estrus synchronization and compared with beef heifers not vaccinated at that time [14], or when revaccination was compared between 40 and 3 days before breeding [13].

When using vaccination to enhance reproductive disease resistance, a balance must be achieved between efficacy and safety, and data are conflicting on the safety of MLV vaccination at or around the time of estrus and breeding. The experiments reported herein were designed to evaluate reproductive safety of an MLV vaccine containing BVDV and BoHV-1. The null hypotheses were that (1) initial MLV vaccination of naive heifers does not affect estrous cyclicity and reproductive hormone concentrations, and (2) MLV revaccination at 10 or 31 days before synchronized natural breeding does not affect response to estrus synchronization and pregnancy rates. The hypotheses were tested by evaluating estrous cycle lengths, hormone concentrations, and pregnancy success when vaccinating heifers with either a multivalent MLV vaccine containing BVDV and BoHV-1 or an inactivated vaccine that did not contain BVDV or BoHV-1.

2. Materials and methods

2.1. Animals

The research described herein was performed under the approval of the Institutional Animal Care and Use Committee of Auburn University (2012-2179). Sixty 1-year-old Angus crossbred beef heifers were enrolled in this study. All heifers were born and raised in biosecure herds, were seronegative to BVDV and BoHV-1, and validated to be free of BVDV and BoHV-1 based on the lack of virus isolation from serum. Before enrollment, heifers were transrectally palpated and determined to have a reproductive tract score of 3 or greater (scale 1–5). Before study initiation, heifers were randomly assigned to one of four treatment groups (A–D) using the random number function in commercially available software (Microsoft Excel; Microsoft Corp., Redmond, WA, USA). Random numbers were generated for each heifer and sorted from low to high. Heifers were assigned to groups A to D for the first 10 replicates and assigned to groups A and B for the last 10 replicates to generate sample sizes of 20 heifers each for groups A and B and 10 heifers each for groups C and D. Descriptive statistics were performed on heifers to assess any differences among treatment groups regarding reproductive tract