

Development of a sole ulcer induction model in Holstein heifers: The next step in lameness research

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Introduction

Lameness continues to be highly prevalent in the dairy industry, negatively impacting cow performance, farm profitability and animal welfare. Affecting around 10% of dairy cows, sole ulcers (SU) are the second most prevalent lesion-based causes of lameness. Sole ulcers are costlier, lead to more greenhouse gas emissions, and are more painful than other lesion types. Despite SU prevalence, studies have thus far failed to explain SU pathogenesis, requiring a new approach to unravel the recurrent, multifactorial nature of SU for use in developing preventative and therapeutic treatment strategies. Our study objective was to develop a SU induction model in heifers during the transition period and to describe physiological, production and behavioral changes during the induction process.

Materials and methods

We randomly assigned 12 pregnant tie-stall Holstein heifers to one of 3 groups: BLK-R, BLK-LPS, or CON. BLK+R animals had hoof blocks on the lateral hoof of the right hind leg from -14 to +28 (± 7) DIM (42 d) and had restrictions to both lying time and DMI on 2 consecutive days per week over the same time period. Lying restriction occurred 2x/d in 3-h time periods with heifers moved to a holding pen with access to water. DMI was restricted to 70% normal intake before each lying restriction day. The same protocol was applied to BLK-LPS heifers, with an added 1-3 lipopolysaccharide (LPS) challenges between 3-28 DIM. Control heifers had no interventions applied. Lying time and DMI were measured daily from -21 to +84 DIM. Daily milk yield was recorded from 0 to +84 DIM. Video gait scoring via a 3-point scale (score 1 = normal, 2 = mildly lame, and 3 = severely lame), visual hoof evaluation, and weight distribution were taken at various times between -21 and +84 DIM.

Results

The challenge model results are preliminary and descriptive. While no SU were reported, 3/4, 2/4, and 0/4 BLK-R, BLK-LPS, and CON heifers, respectively, developed hemorrhages in the lateral hoof of their right leg. Interestingly, 2/4, 4/4, and 3/4 heifers in the same respective groups developed hemorrhages in their left hind leg. Across all time periods, average lying time (h/d) was 12.4(95% CI: 12.0, 12.8) for BLK-R, 12.0(11.8, 12.2) for BLK-LPS and 11.9(11.8, 12.2) for CON heifers. On lying restriction days, lying times for BLK-R and BLK-LPS were 0.35 and 0.32 h/d lower, respectively, than CON. Total DMI (lb/d) during the treatment period was 3.0 and 6.9 less for BLK-R and BLK-LPS than CON, and 9.7 and 12.7 less on DMI restriction days. Weight distribution (% total weight) was more than 2-fold lower

for the right rear leg at block removal of BLK-R and BLK-LPS heifers. However, weight distribution equalized between right and left hind legs by the final evaluation. Prior to block application, 2/4 BLK-R and CON heifers had a gait score > 1 and all BLK-LPS heifers were scored 1. The proportion of gait scores > 1 prior to block removal was 4/4, 3/4, and 1/4 in BLK-R, BLK-LPS, and CON, respectively. Following block removal, gait scores improved. At final evaluation, the proportion of scores > 1 was 3/4, 3/4, and 0/4 in BLK-R, BLK-LPS, and CON, respectively. Milk yield (lb/d) from calving to block removal (21-39 DIM) was 59.7(95% CI: 57.7, 61.8), 50.8(47.3, 54.2), and 55.4(53.0, 57.7) for BLK-R, BLK-LPS, and CON, respectively, and 81.0(80.2, 81.9), 63.4(60.3, 66.5), and 73.5(71.4, 75.6) from block removal to final evaluation (57 d).

Significance

The current challenge model did not induce SU, even with considerable changes in weight distribution and gait. BLK-R and BLK-LPS lying time restrictions were compensated for by increasing lying time during non-restricted periods. Fine-tuning the methodology in different housing conditions (e.g., freestall-housing) in which additional walking on hard surfaces make SU more likely to occur is needed. Using older animals with no history of foot lesions who may be at a higher risk of SU development is also warranted to evaluate the applicability of this SU induction model.

