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Claw horn lesions in mid-lactation primiparous dairy cows under pasture-based systems: Association with behavioral and metabolic changes around calving

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ABSTRACT

The objectives of this study were to describe the lying behavior of primiparous dairy cows under pasture-based systems during the pre- and postcalving period and characterize the association of lying behavior and analytes related to energy metabolism during this period with claw horn disruption lesion development later in lactation. Our convenience sample included 39 primiparous Holstein cows from 3 commercial farms that were assessed for body condition score (BCS; 5-point scale, 0.25-point increments) and had blood collected at wk −3, −2, −1, 1, 2, and 3 relative to calving date. Blood samples were assayed for nonesterified fatty acids, β-hydroxybutyrate (BHB), and cholesterol concentrations. Electronic data loggers (HOBO Pendant G Acceleration, Onset Computer Corporation, Bourne, MA) recorded lying behavior at 1-min intervals from 3 wk before calving to 3 wk after calving. Starting at 4 wk after calving and until 16 wk after calving, cows were examined for claw lesions at approximately 4-wk intervals. Sole lesions and white line lesions were scored on a 0 to 10 scale. Of the 39 primiparous cows, 19 cows scored 0 at all exams during the entire study period and 20 cows had at least 1 severe lesion (score ≥4) between 8 and 16 wk after calving. Time spent lying before calving averaged 10.3 ± 0.3 h/d, but declined to 7.3 ± 0.3 h/d after calving (least squares means ± standard error). At calving, we noted an increase in the number of lying bouts (12.9 ± 0.45 bouts/d) compared with the pre- and postcalving averages of 11.6 (±0.53) and 9.1 (±0.47) bouts, respectively. Cows that developed claw lesions later in mid lactation spent less time lying down than cows without lesions during wk 3 after calving compared with healthy cows (7.29 ± 0.22 vs. 8.51 ± 0.16 h/d). Lesion cows had fewer lying bouts per day, and these bouts were of longer duration than no-lesion cows after calving. Increased odds of lesion were found to be associated with shorter lying times and fewer number of lying bouts during wk 3 (odds ratio = 1.23). Nonesterified fatty acids (747 ± 58 vs. 990 ± 86.85 μmol/L) and BHB (0.77 ± 0.06 vs. 0.60 ± 0.04 mmol/L) concentrations during wk 1 were greater in cows that developed claw lesions relative to cows that did not develop lesions. The BHB concentrations also remained higher in wk 2 for cows that developed claw lesions (0.63 ± 0.04 vs. 0.46 ± 0.03 mmol/L) compared with cows that did not develop any lesions. Cows that developed lesions experienced greater losses in BCS from wk −3 to 3 than cows without lesions (0.74 ± 0.01 and 0.61 ± 0.01 BCS change, respectively). In summary, changes in lying behavior and energy metabolic status after calving were associated with claw horn disruption lesions in mid-lactation primiparous cows under pasture-based systems.

Key words: lameness, negative energy balance, heifers, transition, grazing

INTRODUCTION

Lameness in dairy cattle is one of the most important economic and welfare issues facing the global dairy industry (Huxley, 2013). Lesions categorized as claw horn disruption lesions (**CHDL**; Hoblet and Weiss, 2001), including sole hemorrhage, sole ulcer, and white line disease, are common causes of lameness, and several studies have shown that these lesions are highly prevalent in first-lactation cows (Capion et al., 2009; Maxwell et al., 2015; Randall et al., 2016). For example, a study conducted in Denmark reported a prevalence of 56% for moderate to severe sole hemorrhage and 70% for white line lesions in primiparous cows (Capion et al., 2009). Moreover, studies have shown that previous CHDL lesions constitute a major risk factor for the future development of claw lesions (Foditsch et al., 2016; Newsome et al., 2017b). Thus, reducing the

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risk for claw lesion development in primiparous cows may greatly contribute to an overall reduction in lesion development and, consequently, lameness prevalence in dairy cows.

Some have argued that metabolic and behavioral changes during the transition period, from 3 wk before to 3 wk after calving, increase the risk for CHDL development. Cows with low BCS in the weeks around parturition had an increased risk for developing lameness in general (Hoedemaker et al., 2009), and lameness related to CHDL in particular (Green et al., 2014). Similarly, loss of body fat thickness (as measured by ultrasound) after calving was related to increased risk for sole hemorrhage and lesions (Newsome et al., 2017b). Loss of body fat and low BCS are typically a result of negative energy balance (**NEB**), as experienced by many cows at the onset of lactation. One theory is that loss of body fat also coincides with reduction of fat reserves of the digital cushion, which is mainly composed of adipose tissue (Räber et al., 2004; Räber et al., 2006). As a result, thinning of the digital cushion may then compromise its function of protecting the corium (Bicalho et al., 2009). The metabolites fatty acids, β-hydroxybutyrate (**BHB**), and cholesterol are common measures of NEB in transition animals (Herdt, 2000) and may function as an earlier indicator of metabolic challenge than BCS or body fat loss. However, to our knowledge, no study has investigated the relationship of these metabolites during the transition period with claw horn lesion development further in lactation.

Changes in standing and lying behavior during the transition period may also predispose cows to the development of CHDL (Chapinal et al., 2009; Proudfoot et al., 2010; Dippel et al., 2011). Chapinal et al. (2009) reported that freestall-housed mid-lactation cows diagnosed with sole ulcers lay down less in the weeks before calving but increased their lying time at a faster rate in the weeks following parturition compared with cows that did not develop a sole ulcer. Similarly, Proudfoot et al. (2010) reported that freestall-housed multiparous cows diagnosed with CHDL 13 to 15 wk postpartum stood longer during the 2 wk before and 24 h after calving compared with their healthy counterparts. However, whether changes in standing and lying behavior similarly increase the risk for claw lesions in pasture-based systems is unknown. Given that healthy, nonlame cows housed in pasture-based systems differ in standing and lying behaviors compared to cows housed in confinement (Hernandez-Mendo et al., 2007; Legrand et al., 2009), further investigation of whether changes in these behaviors during transition are a risk factor for lesion development in dairy cows at pasture is needed.

To our knowledge, the majority of information available to date on lying behavior in transition cows has been carried out in a freestall barn environment. Thus, the aims of our study were to (1) characterize changes in lying behavior during the pre- and postcalving period of primiparous grazing dairy cows and, (2) determine if lying behavior and metabolic indicators of energy metabolism can be used to identify cows at risk for claw horn lesions later in lactation. We hypothesized that primiparous dairy cows with reduced lying time and metabolic changes suggesting NEB, both pre- and postcalving, would be at higher risk of developing claw lesions.

MATERIALS AND METHODS

Herd Selection and Management

This prospective observational study was conducted on 3 seasonally calving commercial dairy herds located in the S=southern province of Valdivia, Chile. Herds were selected as a convenience sample based on their proximity to the University Austral de Chile (Valdivia, Chile). Participating dairies met the following criteria: pasture housing during lactation and dry period, spring-calving regimen, more than 200 milking cows of predominantly Holstein breed, and willingness to participate in the study. Average herd size was 590 ± 310 (±SD, ranging from 230 to 980) and average herd milk production was 9,125 ± 1,430 kg annually (ranging from 7,500 to 11,000) based on annual yield estimates. The study was approved by the University Austral de Chile Animal Ethics Committee (#202/2015).

In total, 105 pregnant heifers were enrolled in the study. On all farms, heifers were kept on pastures (mixture of grasses and legumes) until approximately 4 wk before expected calving date, at which time they were moved to a confined straw yard where they remained until calving. Upon moving into the straw yard, heifers were mixed with multiparous prepartum cows in 2 of the herds, whereas in the other herd heifers were maintained separately. On all farms, cows were provided with approximately 10 m^2/cow of straw yard space. Access to feed was provided through a post-and-rail feed barrier system. While feeding, cows were required to stand on a concrete slatted floor that was positioned adjacent to the feed barrier. The prepartum diet was based on a ration consisting of ryegrass hay, corn or grass silage, and chopped straw. The typical composition of ryegrass hay consumed by cows under this system was 18 to 20% CP and 47 to 51% NDF, whereas consumed grass silage contained 14 to 18% CP and 50 to 55% NDF, and corn silage was 7 to 8% CP and 42 to 48% NDF. Cows were