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The effect of digital dermatitis on hoof conformation

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ABSTRACT

Digital dermatitis (DD) is the most prevalent cause of lameness of infectious origin in cattle. However, little is known about the effects of DD on hoof conformation (HC) during the clinical disease. The objectives of the present study were to (1) evaluate the changes in HC observed in feet affected with clinical DD lesions and (2) investigate the temporal relationship between DD and heel horn erosion (HHE). A longitudinal study was carried out including a cohort of 644 Holstein heifers. Digital dermatitis, HC, and presence of HHE in the rear feet of each heifer were assessed during a period of 6 mo. A total of 1,979 feet evaluations were included in the data set, of which 157 corresponded to feet presenting DD lesions >20 mm [mean (SD) size of 27.2 (8.2) mm]. Age, days of pregnancy, hip height, and girth circumference were also recorded at cow level. Significant HC changes were observed in DD-affected feet. Results standardized to a period of 90 d of follow-up showed an increase in heel height [mean (95% CI) 3.4 (2.5, 4.4) and 2.8 (2.0, 3.7) mm] and claw angle [0.8 (0.2, 1.4) and 1.4 (0.7, 2.0) degrees] of the medial and lateral claws, respectively. In addition, an increase in depth of the interdigital cleft [3.2 (2.7, 3.7) mm] and on debris accumulation [14% (7, 21) of feet] was also observed. Feet affected with clinical DD lesions also experienced a 46% point increase in the presence of severe HHE. In the short term, HC changes returned to normal levels when clinical cure of DD was achieved after topical treatment. In conclusion, significant HC changes occur in heifers affected by clinical DD before lameness symptoms are detected. The transformation of the heel area in feet affected by DD likely promotes the creation of a local environment that favors the persistence of the disease and the occurrence of severe HHE. To avoid further hoof damage, active surveillance and early intervention to reduce HC changes are recommended to improve DD control programs. Successful restoration of HC can be achieved upon clinical cure of DD. The long-term effects in lifetime performance of the HC changes due to DD remain to be further investigated.
Key words: hoof conformation, cattle, digital dermatitis

INTRODUCTION

Temporal patterns in hoof conformation (**HC**) changes in dairy cattle have been reported by breed, stage of lactation, or in response to the interaction with different production systems (Becvar et al., 2005; Baird et al., 2009; Bicalho et al., 2009; Telezhenko et al., 2009). Hoof conformation changes have also been associated with the presence of lameness and different claw lesions. Winkler and Margerison (2005) showed a positive association between white line disease and increased length of the dorsal border of the hind feet. Laven (2007) described a significant relationship between digital dermatitis (**DD**) with both heel height and claw length, and van der Linde et al. (2010) showed significant associations between foot angle variations and different hoof diseases. The pathophysiological mechanisms responsible for the relationship between lameness and HC can be described at different levels. Examples for these mechanisms are, at the herd level, the adaptation to different walking surfaces such as concrete or rubber, and the adjustment of daily time budgets to varying management characteristics (Telezhenko et al., 2009; Gomez and Cook, 2010; Navarro et al., 2013). At the cow level, positive genetic correlations have been shown between feet and leg traits and hoof lesions (Chapinal et al., 2013; Häggman and Juga, 2013). In addition, changes in gait due to pain and discomfort experienced by animals affected with certain foot pathologies (Flower and Weary, 2009) can affect normal growth and wear. Last, the external (Winkler and Margerison, 2005) and internal (Bicalho et al., 2009) structures of the foot are modified as a reaction to specific claw horn and skin lesions.

Decreased production and well-being associated with lameness and HC changes are of such importance that a trimming industry has developed with the objective of reestablishing optimal locomotion in cows (Manske et al., 2002) and preserving claw health (Ouweltjes et al.,

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Table 1. Demographic characteristics (mean and SD) observed during each evaluation

	Evaluation 1		Evaluation 2		Evaluation 3	
Demographic characteristic	Mean	SD	Mean	SD	Mean	SD
No. of cows	644		633		356	
Age (d)	540	51	635	53	714	47
Girth circumference (cm)	186	8.3	194	8.1	198	7.4
Hip height (cm)	139	4.0	142	3.6	144	3.6
DCC[1] (d)	75	17.4	171	21.5	250	4.3

[1]DCC = days of pregnancy.

2009). However, therapeutic trimming interventions are often performed exclusively on animals selected by locomotion scores, overlooking animals with hoof lesions that do not show lameness (Offer et al., 2000; Fjeldaas et al., 2011). Lack of overt lameness when hoof lesions are present is evident for DD and other skin disorders (Frankena et al., 2009). When a case of very severe DD is identified, it is normally associated with lameness and with a marked transformation of the original claw shape. In the field, it is common to find "square" feet, characterized by overgrown heels and shortened claws. However, little is known about potential effects on HC caused by DD during earlier clinical stages. Laven (2007) and Olechnowicz and Jaskowski (2010) used a cross-sectional design to show a significant association between DD and heel height. Both studies disagreed, however, about changes in dorsal wall length in relation to DD. Additionally, a further knowledge gap exists regarding the temporal relationship between DD and other hoof diseases. For example, the association between heel horn erosion (**HHE**), a lesion of the heel area generally attributed to lack of hygiene and often observed during the same time periods of high DD risk (Greenough, 2007; Holzhauer et al., 2012), and DD has been shown in studies by Manske et al. (2002) and Capion et al. (2008), but its temporal relationship is unclear.

With the objective of describing how active DD lesions affect HC and evaluating the temporal relationship between DD and HHE, a longitudinal study was performed in a cohort of pregnant heifers.

The study was approved under the Animal Care and Use Protocol No. V-1525 by the Research Animal Resources Center of the University of Wisconsin–Madison.

MATERIALS AND METHODS

A cohort of 644 Holstein heifers was recruited on a commercial dairy operation endemically infected with DD. The heifers were housed in a freestall facility, with recycled sand bedding and with headlocks at the feeding bunk. The stocking density was <1 cow per stall for the duration of the study, which ran from July 2011 to October 2012. A TMR ration composed of haylage (65.6%), wet distillers (7.3%), oat hulls (26.7%), and a mineral premix (0.4%) was delivered once per day. The heifers were eligible to be included in the study if they were pregnant and free of foot skin diseases such as DD, interdigital dermatitis, and HHE upon inspection at enrollment. Baseline demographic characteristics are shown in Table 1.

The rear feet of each heifer were inspected by one of the authors (A. G.) for the presence of DD disease and HC characteristics at enrollment (evaluation 1), and 2 more times (evaluation 2 and evaluation 3) at 3-mo intervals (interquartile range = 2.7, 3.4). Foot evaluations were made in a stand-up chute (M-Series, Comfort Hoof Care, Inc., Baraboo, WI). The dairy was visited 2 to 3 times per week. During each of the evaluations, body measurements, DD diagnosis, and HC were recorded electronically using a custom made Access database (Microsoft Corp., Redmond, WA).

Demographic Characteristics and Body Measurements

Age, days of pregnancy (**DCC**), and health events were obtained from the farm software (DC305, Valley Agricultural Software, Tulare, CA; Table 1). Individual hip height and heart-girth circumference was measured at each evaluation with each heifer standing up in the chute and before any of the legs were attached for inspection. Hip height was measured using a measuring stick (Nasco, Fort Atkinson, WI) placed in between the iliac crests and heart-girth circumference was measured using a tape measure (Weight-By-Breed Dairy Management Tape, Nasco, Fort Atkinson, WI) around the chest, placed snugly behind the front legs and shoulder blades.

Hoof Measurements

Hoof measurements were taken from the right and left rear legs using a caliper (Carrera Precision 9806-