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Technical note: Evaluation of a sonographic overbagging edema scoring system for show cows: Comparison with visual inspection

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ABSTRACT

Overbagged udders are commonly seen at dairy cow shows due to prolonged milking intervals. The aims of this study were to describe the prevalence of udder edema in dairy cows at shows as determined by sonography and to suggest a sonographic scoring system, which was evaluated for reproducibility and repeatability. At 4 highly competitive Swiss dairy cow shows, 319 cows of various breeds were examined. Sonographic scans—1 from each fore quarter and 1 from the rear, representing both hind quarters—were collected by 3 experienced veterinarians at defined positions predisposed to overbagging edema. Sonographic scans were scored with the aid of a newly suggested scoring system (score 0 = no edema, grade 1 = slight edema, grade 2 = moderate edema, grade 3 = severe edema). Further, 139 video sequences from behind while the cows were walking and the same number of photographs of the udder each from the left, right, and behind were selected. The photographs and video sequences were visually scored for different parameters as 0 = not present or 1 = present except for abduction, which was scored on a visual analog scale (0 = no abduction; 100 = maximal imaginable abduction). Visual scores were then compared with the sonographic scoring (Pearson's chi-squared). The prevalence of udder edema scores 1, 2, and 3 was 14.0, 6.5, and 2.3%, respectively. Interobserver reliability for objective sonographic scoring (κ = 0.815) and intraobserver agreement (κ = 0.90 and 0.85 for 2 different observers) was estimated as "almost perfect." Interobserver agreements for visual parameters were κ = 0.40 or less except for teat shape (κ = 0.52). Classification of the videos resulted in better interobserver agreement; when rating hind limb abduction, Spearman correlation coefficient was 0.61, whereas κ = 0.61 for absence of udder movement. Udder movement and teat shape were significantly associated with the edema score. The higher inter- and intraobserver reliability of the sonographic edema scoring compared with the visual scoring system indicates that the newly suggested scoring system might be used in the future to objectively identify udder edema in cows at dairy shows.

Key words: udder edema, sonographic scoring system, overbagging, dairy show

Technical Note

Overbagged udders are commonly seen at dairy cow shows due to prolonged duration of not milking, which occasionally leads to milking intervals of as much as 24 to 36 h (Waller et al., 2007; O'Brien, 2017). This practice is a common part of show preparation, which aims to make an udder appear what is considered to be the ideal udder for competition. The adverse effects of prolonged milking intervals (**PMI**) on a cow's well-being have recently been shown (Kohler et al., 2016). They include behavioral changes such as decreased eating time and increased hind limb abduction as well as nonphysiological status such as increased udder firmness and the development of udder edema. Similar results were described by Bertulat et al. (2017) at dry-off. This study group demonstrated higher udder pressure and a greater increase in stress levels after dry-off in high-yielding cows (yielding ≥16 kg/d at the time of dry-off) compared with a control group treated with cabergoline (to stop milk secretion). The effect of a sudden dry-off on low-yielding cows was negligible. After PMI, edema develops at defined udder locations, and the differentiation of physiological postpartum edema, injection-induced edema, and edema caused by overbagging is possible, mainly according to the sites of occurrence (O'Brien et al., 2002; Waller et al., 2007). Although the exact mechanism leading to edema formation is not known, Melendez et al. (2006) stated that "the highly vascular nature of the bovine mammary gland makes the tissue more prone to develop localized edema due to an increase in blood and lymphatic flow." This refers to periparturient cows. The opposite might occur in

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the case of overbagging edema, as increased pressure in the udder ought to impede venous and lymphatic drainage. This might explain the different locations of periparturient versus overbagging edema, as described by Waller et al. (2007). As demonstrated by Kohler et al. (2016) in Holstein-Friesian cows at 90 d postpartum, udder edema occurred after a PMI of 24 h in 10 out of 15 cows (first sign of edema seen after 18 h), and it was not found in any of the experimental cows after a milking interval of 12 h. Somatic cell count was increased at 12 h after PMI (from 66.3 cells/μL before PMI to 216.3 cells/μL 12 h after PMI; Kohler et al., 2016). Subjective (visual) scoring systems have been developed for describing edema in periparturient cows. The criteria include subjective scoring done by herd personnel without specific instructions (Dentine and McDaniel, 1983) and the use of visual and tactile criteria such as waxy appearance, abnormal udder shape, and recognition of the pitting, which represents a sign of edema, by applying pressure with a fingertip (Tucker et al., 1992). As these scoring systems do not allow an examiner to objectively determine and rate edema formation during overbagging, objective methods for assessing edema associated with PMI are needed. Sonography is a sensitive method for identifying edema (O'Brien, 2017). The sonographic characteristics of edema are best described as "subcutaneous alternating bands of hyperechoic subcutaneous fascial planes and homogenous hypoechoic fluid" (Waller et al., 2007). A reliable system of objectively measuring overbagging at cow shows is therefore required to recognize udder edema and educate the cow's owner about the adverse effect of PMI.

In addition to estimating the prevalence of overbagging udder edema in show cows using sonography, the objectives of this study were to suggest a sonographic scoring system and to evaluate this system for reproducibility and repeatability. Furthermore, the study aimed at adapting the visual udder edema score as described by Dentine and McDaniel (1983) and evaluating its accuracy, defining the sonographic score as the gold standard. We hypothesized that the newly suggested sonographic scoring system provides high inter- and intraobserver agreement and good correlation with the visual udder edema score.

Sonographic scans, video recordings, and photographs of 319 cows were collected at 4 highly competitive dairy shows in Switzerland between September 2016 and April 2017. Of these, 28 cows were examined twice. Sonographic scans of both examinations were used to check inter- and intraobserver reliability of the suggested scoring system. In case of 2 examinations, only the second examination was used to estimate prevalence and provide a comparison with the visual scoring. Twelve cows were excluded from prevalence estimation and comparison with visual scoring (3 cows because they were examined after milking and 9 cows because they calved within the 21 d before the respective show). Therefore, 307 cows were included in these analyses. The breeds involved were Brown Swiss (n = 97), Holstein-Friesian (n = 61), Jersey (n = 20), Montbéliard (n = 23), Original Brown (n = 22), Red Holstein (n = 44), Simmental (n = 19), and Swiss Fleckvieh (n = 21). The age of the cows (mean ± SD) was 4.55 ± 2.21 yr (range: 2.07–14.03 yr), and they were at 115.7 ± 74.2 DIM (range: 22–500 DIM). Based on official milking data of the respective breeder associations, cows yielded 33.4 ± 7.7 kg/d within the month before evaluation (range: 16.1–60.3 kg). Sonographic examination was performed by 3 veterinarians who were experienced in soft tissue scanning (MBo, BO, and AS). Sonographic images were taken before milking using MyLab One (Esaote, Genova, Italy) scanners and a 10-MHz linear probe. As settings, a depth of 5 cm with focus on 1 cm of depth and 70% gain were chosen. Both front quarters and the hind quarters in the area of the central ligament were examined as shown in Figure 1. Sonographic still pictures were blinded as to shows, identity of the cows and owners, and the udder location. Three sets of 50 still pictures were randomly chosen to evaluate unambiguous assignment. The scoring system was modified twice until a final scoring system was obtained, as described in this article. Thereafter, the complete set of sonographic still pictures (n = 1,038) was scored. Grade 0 was defined as no sonographic signs of edema. In the fore and rear quarters, a different definition was given for each sonographic edema score (grade 1 = slight edema; grade 2 = moderate edema; grade 3 = severe edema). The characteristics of each score at different sites are described in the legend of Figure 2. The sonographic still pictures of all cows were independently scored within 2 wk after the last show by 3 experienced scientists (MBa, BO, and AS), all of whom were familiar with evaluating sonographic scans. The interobserver reliability (test for Kendall's coefficient of concordance for ordinal response) of these 3 observers was determined using SAS (SAS Institute Inc., Cary, NC). The intraobserver reliability was determined by 2 experienced scientists (MBa and AS) using NCSS 10 (NCSS LLC, Kaysville, UT) after rescoring the sonographic still pictures 3 mo after their first evaluation. To determine edema prevalence at cow level, the maximal score at quarter level determined the score at cow level, as the score of the quarters within many cows (n = 70) were different.

Additionally, 3 digital photographs of the udders (1 each from the left and right sides and 1 from behind) and a video sequence of the cow walking were taken

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