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Evaluation of claw health in heifers in seven dairy farms using a digital claw trimming protocol and claw data analysis system

Evaluierung der Klauengesundheit von Färsen in 7 Milchviehbetrieben mittels digitaler Klauendatendokumentation und Klauendatenanalyse

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Summary

The claw health of 139 heifers with a mean age of 22.1 months (SD: 2.6) in seven free stall dairy farms in Lower Austria was evaluated. Claw lesions were assessed during functional claw trimming and documented and analysed using the digital program Claw Manager. For documentation of lesions, each claw was divided into 10 zones. The prevalence of lameness, claw lesions and their severity were determined, furthermore the Cow-Claw-Scores (CCS), Farm-Claw-Scores (FCS) and Farm-Zone-Scores (FZS) were calculated. The FCS between farms was tested for significant differences.
A lameness prevalence of 9.4% and an overall prevalence of claw lesions of 98.5% were recorded in these 139 heifers. The most commonly diagnosed disorders were white line lesions (WLL) with a prevalence of 87.1%, heel horn erosion (84.9%), double soles (DS; 47.5%), sole haemorrhages (SH; 33.1%) and a concave dorsal wall contour in 15.1% of the heifers. High correlation coefficients (r ≧ 0.93) were found between SH and DS, WLL and DS.
86.5% of all diagnosed claw lesions were score 1 (mild), 11.1% score 2 (moderate) and 2.4% score 3 (severe) lesions. The CCS in all heifers ranged between 0 and 267, and the FCS in the seven herds was between 11 to 51. Claw zone 3 was affected most frequently and severely.
Following the results of this study, systematic functional claw trimming and consequent documentation of detected claw lesions is highly recommended for heifers at the time of their first insemination to prevent claw disorders in lactating cows and to improve their well-being.

Keywords: lameness, claw manager, cow claw score, farm claw score, cattle

Zusammenfassung

Bei 139 Färsen mit einem mittleren Alter von 22.1 Monaten (± 2,6) aus 7 Laufstallbetrieben in Niederösterreich wurde im Rahmen der funktionellen Klauenpflege eine Kontrolle der Klauengesundheit vorgenommen. Die dabei festgestellten Klauenbefunde wurden mit Hilfe des digitalen Softwareprogrammes Klauenmanager dokumentiert, bei dem jede Klaue in 10 Zonen unterteilt ist.
Die Prävalenz der Lahmheit, der einzelnen Klauenläsionen bzw. -erkrankungen und ihrer Schweregrade wurden ermittelt, weiters wurde der Kuh-Klauen-Score (CCS), der Farm-Klauen-Score (FCS) und der Farm-Zonen-Score (FZS) berechnet; der FCS der einzelnen Betriebe wurde auf Signifikanz geprüft.
Die Lahmheitsprävalenz lag bei 9,4 %, die Gesamtprävalenz der erhobenen Klauenläsionen bei den 139 Färsen betrug 98,5 %. Die am häufigsten diagnostizierten Klauenerkrankungen waren Wanddefekte mit einer Prävalenz von 87,1 %, Ballenhornfäule (84,9 %), Doppelsohlen (47,5 %), Sohlenblutungen (33,1 %) und eine konkave Dorsalwandkontur bei 15,1 % der Färsen. Signifikante Korrelationen bestanden zwischen dem Auftreten von Sohlenblutungen und Doppelsohlen sowie zwischen Wanddefekten und Doppelsohlen (r ≧ 0.93). Bezogen auf die Schweregrade der Klauenbefunde, wurden bei 86,7 % der Färsen geringgradige

(Score 1), bei 11,1 % mittelgradige (Score 2) und nur bei 2,4 % hochgradige (Score 3) Befunde festgestellt. Die CCS Werte der 139 Färsen lagen zwischen 0 und 267, der FCS in den 7 Herden zwischen 11 bis 51. Am häufigsten und schwerwiegendsten war Zone 3 betroffen.
Aufgrund der Ergebnisse dieser Studie wird die Durchführung einer systematischen funktionellen Klauenpflege mit Dokumentation der Befunde bei Färsen zum Zeitpunkt der ersten Besamung unbedingt empfohlen, um Klauenerkrankungen bei Kühen vorzugebeugen und das Wohlbefinden der Tiere zu verbessern.

Schlüsselwörter: Lahmheit, Klauenmanager, Kuh-Klauen-Score, Farm-Klauen-Score, Rind

Introduction

An annual lameness incidence of 54.6% was reported by Clarkson et al. (1996) in 37 dairy herds in England. A much higher incidence of 70% was found in 900 cows by Green et al. (2002), however Leach et al. (2010) reported an average lameness prevalence of 36% on 222 dairy farms. In a survey of 80 Austrian dairy herds, a lameness prevalence of 36% was assessed too (Rouha-Mülleder et al., 2009). The localisation of lameness in dairy cattle is limited to claws and digits in up to 90% of cases (Clarkson et al., 1996; Murray et al., 1996; Manske et al., 2002). Lameness is of great economic importance, ranked third after mastitis and reproduction disorders (Green et al., 2002; Hernandez et al., 2002; Ettema et al., 2007; Sogstad et al., 2007; Amory et al., 2008). Culling during first lactation due to claw and limb disorders is ranked as the fifth most frequent cause of loss of Simmental and Holstein-Friesian (HF) cows in Austria (Zuchtdata, 2009).

During the last years researchers increasingly focused their attention on claw health of heifers. Sole haemorrhages (SH) were reported in 70% of 10 months (Frankena et al., 1992) and in 77% of 13 months old HF-heifers (Vermunt and Greenough, 1996). Hoblet et al. (2000) documented a prevalence of 84% claw disorders in 12–13 months old HF-heifers. However, Drendel et al. (2005) found a prevalence of 85.1% white line lesions (WLL), SH and heel horn erosion (HHE) in HF-heifers one month before calving.

Webster (2002) observed that heifers, housed in straw yards for the last four weeks of gestation and the first eight weeks of lactation had fewer SH and WLL than those kept in free stalls on concrete floors during the same period. Housing in slatted pens with more than 7 calves from 3 to 7 months was found to be associated with a 1.7-fold increase in risk of culling in dairy cows (Hultgren and Svensson, 2009). Capion et al. (2008) found, that 25% of Danish Holstein heifers had locomotion scores exceeding 2 just before calving.

In the past, paper recording sheets were used to document claw data for scientific studies, (Murray et al., 1996; Greenough et al., 1997; Whay et al., 1997), or a combination of photography and a paper based protocol (Leach et al., 1998; Smilie et al., 1999; Capion et al., 2008). In claw trimming practice in Austria and Germany, documentation was traditionally carried out using paper, if at all (Hulek, 2005; König et al., 2005, Pesenhofer et al., 2006). In course of the last few years, digital documentation programs were developed (Pijl, 2004; Landmann et al., 2004; Landmann and König, 2006; Feucker, 2009).

The first objective of the present study was to evaluate the prevalence and type of claw disorders in heifers, from the time of the first insemination until about two months before calving. A further purpose was to document these findings using a novel digital protocol and claw data analysis system allowing an easy comparison of the claw health status of heifers in different farms.

Material and Methods

Animals

In seven free-stall-barn dairy farms in Lower Austria heifers of 13 months or older were selected, until 2 months before calving. The mean age of the examined heifers was 22.1 months (SD: 2.6; range 13.5 to 31.2 months), 127/139 heifers were inseminated or pregnant at the time of the study.

Locomotion scoring

Locomotion scoring was based on the system published by Sprecher et al. (1997), where score 1 describes a normal gait with a flat back posture while standing and walking, and score 5 a severely lame cattle showing a pronounced arching of back and reluctance to move, with almost complete weight transfer. Locomotion of heifers on the solid concrete or slatted floor to the tilt table was scored and documented.

Claw examination and documentation of data

Functional claw trimming was carried out with the heifers restrained on a tilt table by the authors J.K and A.H. Angle grinders fitted with either a seven steel knife disk or a metal granulate fitted disk and hoof knifes were used. Trimming technique was according to the Dutch standard (Toussaint Raven, 1989). After step 3 of functional claw trimming, all the claws of each heifer were examined thoroughly for the presence of claw horn and skin lesions.

The identified lesions were documented using the digital software program Claw Manager. Animal (ear tag numbers) and farm data such as type of housing, flooring, type of lying area, bedding material, the availability of a paddock or pasture were registered manually.

The registration of claw lesions with this program was simple, it was carried out using a laptop: after clicking the button "New animal" the "Navigation cow" screen (Fig. 1) appeared showing the 4 limbs and the 4 claw-pairs. The digital documentation application was arranged on this digital claw-pair graph, with each claw

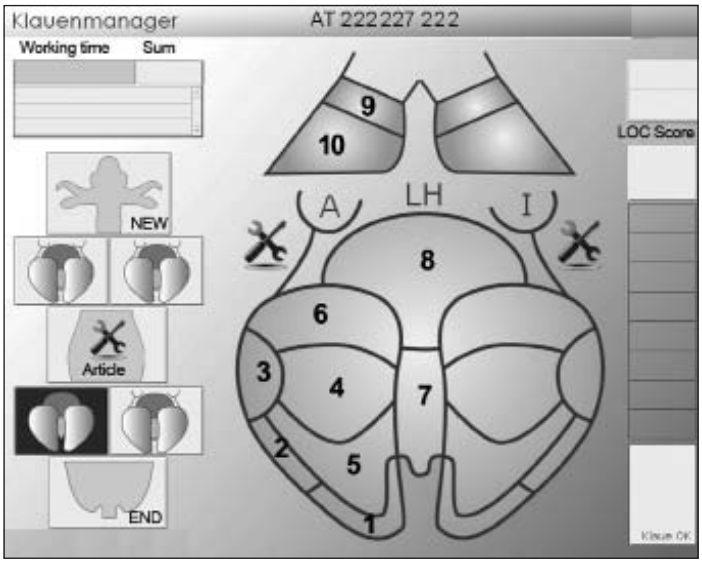

FIGURE 1: *Mask of the „Claw Manager" showing the „Navigation cow" on the left, the claw-pair of the left hindclaw with the 10 zones; A: lateral claw; I: medial claw; LH: left hindlimb; LOC Score: Locomotion score; NEW: Claw data documentation for a new cow; END: End of claw data documentation; Article: Documentation and billing of articles for claw treatments.*

divided into 10 zones based on Greenough and Vermunt (1991) and Greenough et al. (1997). By clicking for example on the left hindclaws this claw-pair screen appeared, and after touching the affected claw zone, in each of the 10 zones for this area relevant diagnoses were offered for selection. Then, the assessed lesion was documented by touching the corresponding "diagnosis" button. Furthermore, treatments and materials used as well as working time were recorded (Fig.1).

Twelve defined claw lesions and three severity scores of each lesion (Tab. 1), the latter according to recommendations of Smilie et al. (1999) were recorded. The three severity scores were displayed in colour using the "traffic-light colour scheme", with green indicating a slight (score 1), yellow a moderate (score 2), and red a severe form (score 3) of the lesion. Locomotion scores were assessed by J.K. Corkscrew claws, and abnormally low heel height of medial hindclaws were also noted.

All the identified claw lesions were treated by functional claw trimming (step 4). In lame heifers (≧ score 3) a regional intravenous anaesthesia was applied for surgical removal of the involved infected tissue (white line lesions: WLL; double soles: DS; interdigital phlegmon: IP), and if necessary, a rubber or plastic block was attached on the partner claw.

TABLE 1: *List with the 12 defined claw lesions/disorders in the Claw Manager programme, their three severity scores and their description*

Term of the lesion/ disorder	Severity score	Description of the severity scores of the lesions/disorders
Chronic laminitis	1	Concavity of dorsal wall to 5 mm, ridges and grooves
	2	Concavity of dorsal wall to 8 mm, ridges and grooves
	3	Concavity of dorsal wall > 8 mm, ridges and grooves
Sole haemorrage	1	Yellowish to slight red discoloration
	2	Pale red discoloration
	3	Dark red discoloration
Sole ulcer	1	diameter < 1 cm, superficial corium inflammation/damage
	2	diameter 1–2.5 cm, partly necrotic changes of corium
	3	Diameter > 2.5 cm, deep necrotic changes
White line disease	1	Separation within white line
	2	Separation within white line and infection of about half of the wall-corium
	3	Infection of full length of the wall-corium with possible fistula formation at the coronary band or involvement of bone/tendon
Double sole	1	Separation in the sole with a small < 1.5cm within the sole horn
	2	Separation in the sole with a larger > 1.5cm cavity within the sole horn and accumulation of dirt
	3	Separation in the sole with a large cavity > 3cm within the sole horn and/or purulent exudate within the cavity
Heel horn erosion	1	Slight V-shaped defects on the bulbar horn
	2	V-shaped defects running diagonally across all of the heel
	3	Deep V-shaped defects running diagonally across the heel with additional swelling of the bulbs of the heel or/and superficial inflammation of bulbar corium
Swelling of the coronet	1	Slight swelling without discoloration of skin
	2	Obvious swelling with a slight topical discoloration (brown-reddish)
	3	Severe swelling of the whole coronet with an obvious discoloration
Vertical fissure	1	Superficial and extending vertically for a variable distance from the coronary band distally or from the distal wall margin proximally
	2	Superficial and extending vertically over the complete wall lenght
	3	Reaching deep to the corium (purulent) and extending vertically over the whole wall lenght
Digital Dermatitis: DD	1	Acute lesion with a diameter of ≦1 cm, M1 lesion
	2	Acute lesion with a diameter of 1–3 cm, M2 lesion
	3	Acute lesion with a diameter > 3 cm, M2 lesion
DD chronic	1	Chronic lesion without pain, M4 lesion
Interdigital hyperplasia	1	Small hyperplasia without widening of interdigital space
	2	Moderate hyperplasia with widening of interdigital space
	3	Large sized hyperplasia with widening of interdigital space and inflammation of the skin
Interdigital phlegmon	1	Swelling of the interdigital tissues with spreading of the claws
	2	Additonal inflammatory changes and/or fissure(s) of the interdigital skin with severe swelling dorsal an palmar/plantar
	3	Additonal necrotic changes of the interdigital skin with severe swelling of the whole digital region

TABLE 2: *Distribution, mean age, type of flooring, of lying area of heifers and Farm-Claw-Score in the seven farms*

	Herd size/ number of dairy cows per farm	Mean age of heifers in months	Number of heifers/ farm included in the study	Housing/flooring system	Lying area	FCS: Farm-Claw-Score
Farm 1	65	20.7	12	Solid concrete floor, solid concrete paddock, pasture	Cubicles with deep straw bedding	11
Farm 2	60	22.8	12	Rubber mat floor	Cubicles with deep straw bedding	20
Farm 3	130	23.8	34	Slatted floors	Cubicles with deep straw bedding	35.5
Farm 4	230	24.8	44	Slatted floors	Cubicles with rubber mats without straw	34
Farm 5	42	24.5	10	Straw yard + solid concrete floor	Straw yard; Cubicles with deep straw bedding	49
Farm 6	55	18.1	13	Straw yard + Slatted floors	Straw yard; Cubicles with deep straw bedding	38
Farm 7	24	19.7	14	Straw yard + solid concrete paddock	Straw yard	55

Data processing by the Claw Manager

Three parameters were calculated from the claw data obtained: The geometric severity scores for all 10 zones of all eight claws were added resulting in the Cow-Claw-Score (CCS) for each animal based on recommendations of Greenough and Vermunt (1991), Leach et al. (1998) and Smilie et al. (1999) with slight modifications.

The Farm-Claw-Score (FCS) is the median of all CCS of a herd, 50% of the values are higher and 50% are lower (Huber et al., 2004). The lower the CCS and the FCS count the better, a good CCS/FCS for heifers is < 35.

The FZS (Farm-Zone-Score) is the total of all CCS of all the cows of a herd for each particular zone. This parameter was newly established for recognition of the most frequently and severely affected claw zones in a herd, which is important to identify risk factors.

Statistical analyses

Analyses of the data was performed using Microsoft Excel 2003 and IBM SPSS Statistics 17. The prevalence of lameness, diagnosed claw lesions, their severity scores 1–3, and the CCS of the 139 heifers were evaluated by the Claw Manager program. The FCS of each of the seven farms was calculated and a one-way ANOVA applied to test for significant FCS differences between farms, and the paired t-test for significant disparity in lesion distribution between lateral and medial claws. To document relationships between various claw lesions Spearman correlation coefficients were calculated. The significance was set at $P < 0.05$.

Results

Animals and farms

Claw data of 139 heifers of different breeds (Simmental: 133; Pinzgauer: 4; Brown Swiss: 1 and HF: 1) from seven different free stall barn dairy farms in Lower Austria were documented within the period of October 2009 to April 2010. None of these heifers had their claws trimmed prior to the examination. The number of lactating cows of these farms ranged between 24 (farm seven) and 230 (farm four) with a mean of 86 cows (Tab. 2). The mean annual milk yield was 7832 kg, ranging from 5100 kg (farm seven) to 9680 kg milk (farm four). The mean first calving age of Austrian Simmentals is 29.8 months (Zuchtdata, 2009).

Table 2 shows the number of dairy cows and examined heifers per farm, their mean age, type of flooring, bedding and the calculated FCS of each farm. All the heifers were kept in loose housing systems, but there was a high variation within the stall design of these seven farms, regarding the quality of flooring surfaces and paddocks, the exposure to manure and overstocking. For example the concrete walk-ways of farms five and six were slippery, and in farm seven the alley behind the feeding bunk was too short for the animals to stand square.

Locomotion scores

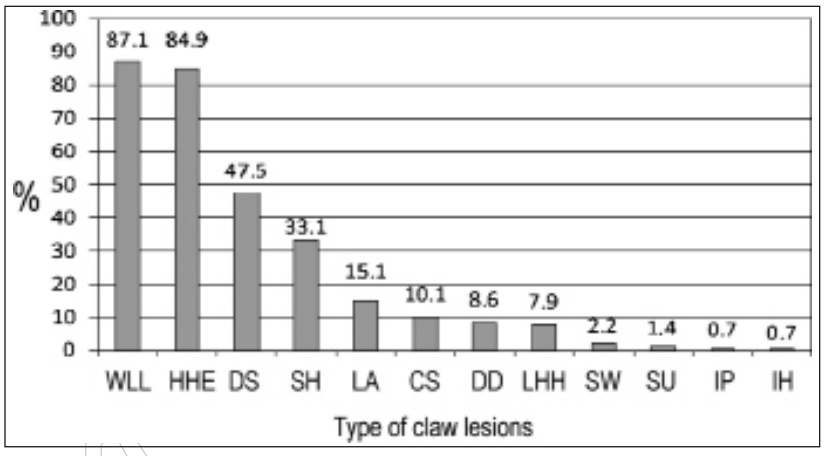

FIGURE 2: *Prevalence of the diagnosed claw lesions in 139 heifers; WLL: White line lesion; HHE: Heel horn erosion; DS: Double sole; SH: Sole haemorrhage; LA: chronic laminitic claw; CS: Corkscrew claw; DD: Digital dermatitis; LHH: Low heel height on medial hindclaw; SW: Swelling of the coronet/or bulbs of the heel: SU: Sole ulcer; IP: Interdigital phlegmon (foot rot); IH: Interdigital hyperplasia.*

TABLE 3: *Distribution of type, number and percentage of diagnosed claw lesions of score 1 (mild), score 2 (moderate) and score 3 (severe)*

Diagnosis/Lesion	Number (%) of heifers with score 1 lesions		Number (%) of heifers with score 2 lesions		Number (%) of heifers with score 3 lesions	
White line lesion (WLL)	117	84.2%	16	11.5%	6	4.3%
Heel horn erosion (HHE)	116	83.5%	10	7.2%	-	
Double sole (DS)	63	45.3%	10	7.2%	4	2.9%
Sole haemorrage (SH)	46	33.1%	3	2.2%	-	
Chronic laminitis (LA)	21	15.1%	5	3.6%	-	
Digital dermatitis acute (DD)	3	2.2%	3	2.2%	-	
Total number of lesions	366	86.5%	47	11.1%	10	2.4%

TABLE 4: *Claw zones with the highest claw scores within the farms, the corresponding FZS, and distribution of the most frequently diagnosed claw lesions in 139 heifers within the seven farms; FZS: Farm-Zone-Score; L: lesion type; WLL: White line lesion; HHE: Heel horn erosion; DS: Double sole; SH: Sole haemorrhage; LA: chronic laminitic claw; DD: Digital dermatitis*

Farm	Claw zones with highest scores in descending order						Prevalences of the most frequently diagnosed claw lesions in the 7 farms in descending order									
	zone	FZS	zone	FZS	zone	FZS	L	%	L	%	L	%	L	%	L	%
1	3	80	7	64	4	44	SH	75.0	WLL	58.3	HHE	25.0	DS	16.7	IP	8.3
2	3	104	6	100	2	40	WLL	91.7	HHE	66.7	-		-		-	
3	6	500	3	292	4	250	HHE	87.2	WLL	74.4	DS	53.8	SH	35.9	DD	20.6
4	3	976	6	587	4	312	HHE	100.0	WLL	97.2	DS	52.5	SH	32.4	LA	23.5
5	10	210	6	136	3	124	WLL	100.0	HHE	80.0	LA	60.0	SH	40.0	DS	39.0
6	3	180	6	154	4	48	WLL	92.3	HHE	84.6	DS	46.2	SH	30.8	LA	15.4
7	4	312	10	265	3	236	HHE	93.8	WLL	81.3	DS	75.0	LA	68.8	SH	37.5

126 heifers (90.6%) revealed a locomotion score 1 indicating that they were not lame; 13/139 heifers (9.4%) were lame: 4/13 (2.9%) had a score 2, 8/13 (5.8%) showed score 3 lameness. One single heifer revealed a score 4 lameness caused by an IP. In ten heifers the lameness was caused by a score 3 (6/10) and score 2 WLL (4/10) and in two by a score 3 double sole.

Diagnoses

The prevalence of claw lesions diagnosed in these 139 heifers are listed in Figure 2. An overall prevalence of claw lesions of 98.5% was recorded, the number of lesions per heifer (of eight claws) ranged between 0 and 28. Table 3 displays the distribution of the diagnosed severity scores of the lesions; in nearly all heifers more than one lesion per claw was observed. The predominant claw lesions in these heifers were WLL with a prevalence of 87.1% followed by HHE (84.9%), DS (47.5%), SH (33.1%), concave dorsal wall shape and alternating grooves and ridges indicating chronic laminitis (15.1%), cork-screw claws (10.1%), digital dermatitis (DD; 8.6%) and sole ulcers (SU; 1.4%) (Fig. 2).

Significant correlations were found for many lesions. The largest correlations ($P < 0.05$) between the various lesions of all heifers from the seven farms were between SH and DS ($r = 0.96$), WLL and DS ($r = 0.93$), corkscrew claws and HHE ($r = 0.95$), corkscrew claws and DS ($r = 0.81$); corkscrew claws and WLL ($r = 0.79$) and between SH and SU ($r = 0.80$). Furthermore moderate correlations were determined between concave dorsal wall (chronic laminitic claw) and DS ($r = 0.62$), concave dorsal wall and SH ($r = 0.61$), WLL and SU ($r = 0.60$), and HHE and DD ($r = 0.55$; $P = 0.05$).

Regarding the severity of claw lesions, score 1 (mild) lesions were diagnosed in 86.5%, score 2 lesions in 11.1% and score 3 (severe) lesions (WLL and double soles only) in 2.4% of heifers only (Tab. 3). Considering all claw lesions, hindclaws were affected in 52.2% of cases, foreclaws in 47.8%, lateral claws in 59.6%, medial claws in 39.4% and the interdigital skin in 1%. Focussing on the distribution of lesions between medial and lateral claws, significant differences were found in hindclaws ($P = 0.028$) and foreclaws ($P = 0{,}0003$). 91.6% of score 1, 5.1% of score 2 and 0.2% of score 3 lesions were located on medial and 94.7% of score 1, 7.0% of score 2 and 1.4% of score 3 lesions were diagnosed on lateral claws.

CCS, FCS and FZS

The CCS of all 139 heifers ranged from 0 to 267, the FCS between 11 and 55 (Tab. 2). Table 4 shows the distribution of the claw zones with the highest claw scores within the seven farms, the corresponding FZS, and the most frequently diagnosed claw lesions in the seven farms in descending order. In five of seven farms, zone 3, representing the abaxial plantar/palmar third of the weightbearing rim of the wall, showed the highest or second highest incidence, respectively, with the highest FZS, followed by zone 6 (bulbs of the heel) and zone 4 (axially on the sole). In 80.2% SH were diagnosed in zone 4, and in 19.8% in zone 5 at the toe area.

In five of seven farms the two most frequently identified claw lesions were WLL followed by HHE (Tab. 4). However, in farm one SH and in farm seven double soles were the disorders of highest prevalence. In farm five and seven in 60.0% and 68.8% of the heifers, respectively, chronic laminitic claws were detected, whereas in farms one, two and three none of the heifers showed this lesion. In farm two, with a rubber mat floor, only two types of disorders, namely WLL and HHE, were diagnosed (Tab. 4).

Table 5 displays the statistical significance in difference of the FCS between the seven farms. The FCS of farms one and two were significantly different from those of farms four, five and seven. The FCS of farm three revealed a significant difference to those of farms four and seven. Merely the FCS of farm six showed no statistically significant differences to data obtained in other farms.

TABLE 5: *Analysis of the Farm-Claw-Score (the median of all Cow-Claw-Scores of a herd) of the 7 farms showing significant differences between the farms (in bold). The significance level was set at $P < 0.05$*

Farm	Farm						
	1	2	3	4	5	6	7
1		0.739	0.108	**0.002**	**0.023**	0.142	**0.001**
2	0.739		0.227	**0.008**	**0.049**	0.258	**0.003**
3	0.108	0.227		**0.041**	0.220	0.885	**0.013**
4	**0.002**	**0.008**	**0.041**		0.937	0.182	0.292
5	**0.023**	**0.049**	0.220	0.937		0.348	0.397
6	0.142	0.258	0.885	0.182	0.348		0.054
7	**0.001**	**0.003**	**0.013**	0.292	0.397	0.054	

Discussion

Currently in Austrian dairy herds, little attention on claw health of heifers is paid by farmers, claw trimmers and veterinarians (Kofler, 2009). However, lameness and claw disorders were identified as major animal welfare issues by the Farm Welfare Council (FAWC, 1993). Therefore,

this study aimed to collect data of the claw health status of heifers in Austrian dairy farms for the first time, using the new digital documentation and analysis program Claw Manager.

In these 139 heifers, a prevalence of 98.5% was assessed for claw lesions in one or more claws. Capion et al. (2009) diagnosed at least one claw lesion in 95% of Danish HF-heifers from five herds housed either in cubicle stalls with concrete alleys or straw yards with slatted floors at the first recording. Hoblet et al. (2000) and Drendel et al. (2005) found a prevalence of 84% and 74.4% respectively for the presence of claw lesions in 12–13 months old HF-heifers in the US. These results with about 15% to 25% lower prevalence of claw lesions compared to our study may be explained by the applied documentation method using only seven claw zones or by the different housing systems in open, earth-mounded lots (Drendel et al., 2005).

The most common lesions in these heifers were WLL, with a prevalence of 87.1%. WLL together with HHE were the most frequently identified lesions in five of seven farms. Capion et al. (2009) found a much lower prevalence (44%) of WLL in heifers before calving. WLL and white line disease develop typically and frequently as sequelae of chronic laminitis (Ossent and Lischer, 1998), however beside nutritional factors, mechanic and traumatic influences due to inadequate flooring and environmental conditions may be causative too (Webster, 2002; Telezhenko, 2007; Bell et al., 2009; Sanders et al., 2009; Cook and Nordlund; 2010).

We assume that exogenous, traumatic factors played a major role in the development of WLL in these heifers, since merely a low prevalence of SH (33.1%) and chronic laminitis (15.1%) could be determined. Also Bergsten and Frank (1996) reported a higher number and more severe claw lesions in heifers exposed to hard surface. However, in farm five and seven 60.0% and 68.8% of the heifers, respectively, had chronic laminitic claws, therefore nutritional influences can be assumed as causative for the high prevalence of WLL and DS in these two herds.

Most frequently (84.2%) mild score 1 lesions with only a small separation of the white line were found, in 4.3% only a score 3 lesion with purulent discharge at the coronet was diagnosed. The most frequently affected claw zone in all of these heifers with the highest FZS was zone three, the abaxial plantar/palmar third of the white line area, which is subjected greatest to mechanical stress (Mülling, 2002). The FZS represents the most frequently and severely affected zones; hence there was not always a direct relationship between the score rate and the prevalence of affected claws in individual farms. Cows suffering from a severe white line disease reveal high lameness scores and inflammed swelling of the coronet or the bulbs of the heels (Collick, 1997a; Nuss and Steiner, 2004; Dirksen, 2006). In this study, three heifers classified with score 3 WLL also showed a swelling of the coronet and a lameness score of 3/HHE was ranked second of the claw lesions with a prevalence of 84.9%, but only score 1 and 2 lesions were recorded. HHE is rarely a causing factor for lameness (Collick, 1997c; Dirksen, 2006), but the increased and ample horn maceration results in debilitation of bearing weight on the plantar/palmar sole horn and an increased susceptibility to local skin infections such as DD (Bergsten, 1997; Nuss and Steiner, 2004; Dirksen, 2006; Capion et al., 2009). A moderate correlation (r = 0.55) was calculated between HHE and DD in these heifers.

Double soles were detected with a prevalence of 47.5%. However, more than 81% had a score 1 indicating a small cavity within the sole horn, and only 5% had a score 3 double sole, extending across the complete horn sole or filled with purulent exudate. Haemorrhages of the sole corium caused by laminitis or trauma lead to a localised or large separation of the sole horn layer from the corium; this pathogenesis is confirmed by the high correlation (r = 0.96) between SH and DS. When new horn is produced, the cavity formed by the former bleeding and a new thin horn layer moves distally (Collick, 1997b; Ossent and Lischer, 1998). Therefore, double soles may be entrance portals for infection to the solar corium, frequently causing severe lameness (Nuss and Steiner, 2004).

SH were recorded in 33.1% of heifers; no score 3 SH were documented. Most often (80.2%) SH were found at zone 4 axially on the sole at the level of the flexor tuberosity, but also the toe and the white line area may be affected. As mentioned, SH are caused by laminitis or mechanical insults of the solar corium from outside (Collick, 1997b; Ossent and Lischer, 1998; Mülling, 2002; Webster, 2002).

However, Frankena et al. (1992) and Vermunt and Greenough (1996) reported a prevalence of 70% and 77% respectively for SH in HF-heifers, which is nearly twice as high than the results of this study. A possible explanation for this large difference in the prevalence may be the different influence of housing and feeding circumstances (Bergsten and Frank, 1996; Offer et al., 2001, 2003; Leach et al., 2005; Hultgren and Svensson, 2009). This theory is supported by the rather low prevalence of chronic laminitic claws in this study.

Chronic laminitis with the typical concave dorsal wall, alternating grooves and ridges of the wall (Ossent and Lischer, 1998) was recorded in 15.1% of heifers. Chronic laminitic claws are much more susceptible for environmental factors such as moisture and pressure resulting in an increased frequency of WLL, double sole, sole ulcer, toe ulcer and HHE (Ossent and Lischer, 1998; Van Amstel and Shearer, 2006; Sanders et al., 2009; Cook and Nordlund; 2010; Kujala et al., 2010). For the heifers in this study moderate correlations were found between chronic laminitic claws and DS (r = 0.62) and SH (r = 0.61) respectively.

Also the presence of corkscrew claws and too low heel height of medial hindclaws was documented. These pathological and irregular claw shapes are predisposing factors for the development of SH, WLL and sole ulcer due to the non-physiological biomechanical load conditions (Van Amstel et al., 2002a; Fiedler et al., 2004). For corkscrew claws, a prevalence of 10.1% was determined. High correlations were noted between corkscrew claws and HHE (r = 0.95), DS (r = 0.81) and WLL (r = 0.79) respectively. Insufficient heel height of the medial hindclaws had a prevalence of 7.9%; this is regarded as a genetic condition (König et al., 2005) that makes it difficult or impossible to ensure balance between the heels of medial and lateral hindclaws (Van Amstel et al., 2002b). Furthermore the anatomically 2 to 4 mm longer fourth metatarsal bone and longer lateral phalanges (Nacambo et al., 2007) are regarded to be the cause of the higher frequency of claw disorders of lateral hindclaws in dairy cows (Clarkson et al., 1996; Nuss and Steiner, 2004; Van

Amstel and Shearer, 2006). Not surprisingly, in this study lesions of lateral claws were found in 59.6%; however, regarding score 2 and 3 lesions only, 21.4% of them were diagnosed on lateral and 8.6% in medial claws. Incorrect claw trimming may be excluded as a cause for insufficient heel height (Van Amstel et al., 2002b; Fiedler et al., 2004; Hulek, 2005) in these heifers, since they had not been trimmed prior to examination.

Already in these young stock, 8.6% of the heifers were affected by DD, this disease was found in two out of seven herds. DD is recognised in many countries as the most important infectious claw disease of dairy cows (Wells et al., 1999; Capion and Enevoldsen, 2004; Losinger, 2006; Holzhauer et al., 2006; Amory et al., 2008). In Austria DD plays a minor role for herd lameness at present; however, the DD herd prevalence increased within the last years to 14.9% according to a study on first lactation cows (Hulek et al., 2010).

Sole ulcers were found only in two (1.4%) heifers. An explanation for this low prevalence is that heifers are not challenged by the same metabolic conditions as lactating cows, furthermore their body weight is much lower (Lischer et al., 2002; Dirksen, 2006; Van Amstel and Shearer, 2006; Sanders et al., 2009; Cook and Nordlund, 2010). A high correlation was determined between SU and SH ($r = 0.80$) and a moderate between SU and WLL ($r = 0.60$), however the validity of these correlations is compromised by the very low number of sole ulcers.

Interdigital phlegmon and interdigital hyperplasia were diagnosed in two heifers only, which is an equal low level as recorded for interdigital phlegmon in dairy cows (Bergsten, 1997; Reinöhl-DeSouza and Kofler, 2006), and interdigital hyperplasia in heifers and dairy cows (Collick, 1997d).

In comparison to other studies in dairy herds with reported lameness prevalence/incidence rates of 36% to 70% (Clarkson et al., 1996; Green et al., 2002; Rouha-Mülleder et al., 2009), the present study revealed a relatively low lameness prevalence of 9.4%. In contrast, Capion et al. (2009) described a prevalence of lameness scores ≧ 3 in 147 Danish HF-heifers before calving of 25%. In the present study, the prevalence of lameness score 3 was only 5.8%, all other heifers revealed a lameness score 2, one case had a score 4/5.

When regarding a 10% lameness prevalence in dairy herds as a maximum bench mark, that can still be tolerated economically (Vermunt and Greenough, 1997; Robinson and Juarez, 2003; Tomlinson et al., 2006), the 9.4% lameness prevalence in heifers which are not exposed to the metabolic conditions of lactating cows seems to be too high. This appraisal is underlined by long-term studies showing that heifers suffering from claw disorders at an age of 13 months and one month before calving have a 15 to 27 times increased risk of becoming lame during first lactation, respectively (Hoblet et al., 2000; Drendel et al., 2005). While a 25% prevalence of locomotion score ≧ 3 was found in heifers before calving, it increased to 90% at approximately 250 days in milk (Capion et al., 2009).

At the first sight, the results of this study show a discrepancy between the determined high prevalence of 98.5% of claw lesions and the contemporary low lameness prevalence of 9.4%. This finding is not surprising, since a larger number of diagnosed claw lesions did not cause any pain. Hence, most of these lesions- especially score 1 and 2 lesions – were not necessarily associated with lameness (Smilie et al., 1999; Van Amstel et al., 2002b; Fiedler et al., 2004; Nuss and Steiner, 2004; Hulek, 2005) except the detected severe score 3 WLL and double soles (Whay et al., 1997). Similar results were reported by Manske et al. (2002) in Swedish dairy cows with a prevalence of 72% of at least one claw lesion per cow, despite a lameness prevalence of only 5.1%.

It can be assumed that in these heifers, showing WLL and DS with a score 2 without evidence of lameness, painful claw disorders would have had developed within few weeks, if the claws had not been trimmed and the lesions treated professionally by removing the load from the affected claw zones (Manske et al., 2002; Huber et al., 2004).

For this study the digital documentation program Claw Manager was applied. Documentation in practice can be carried out using either a shockproof and washable touchscreen connected with a laptop, a tablet PC or using a laptop only. The integrated software allowed to perform and print an analysis of the recorded claw data – such as the prevalence of diagnosed claw lesions, of their severity scores, of lameness, and the recognition of the most frequently affected claw zone, and an automatical calculation of CCS, FCS and FZS – immediately after completion of the trimming procedure on the farm. For the farmer and farm veterinarian a modern tool for claw health control may be offered, based on real and regularly recorded data as well as international reference marks (Greenough and Vermunt, 1991; Leach et al., 1998; Robinson and Juarez, 2003), and integration of methods used until now only for scientific evaluation of claw health, such as CCS (Greenough and Vermunt, 1991; Leach et al., 1998; Smilie et al., 1999) and FCS (Huber et al., 2004). Additionally, a long-term course of herd claw health may be monitored easily; also a comparison of claw data of different farms is now very easy and quick, due to the parameter FCS. The FCS expresses the claw health of the herd in one number in a similar manner as the somatic cell count for the bulk milk of a farm (Emanuelson and Funke, 1991) and can therefore be used by the farmer as a management tool. Based on the observation and experience of the authors over a period of 1.5 years evaluating the digital claw data of over 350 herds in Austria and comparing these data with the corresponding animals, a CCS and FCS < 35 as a bench mark was found to indicate a reasonably good herd claw health of heifers. The range of the FCS between the farms varied widely, farms one and two had the lowest values. As reasons for this the adequate flooring, environmental and feeding conditions have to be addressed. Adequate feeding conditions have to be present, as in none of the heifers of these two farms chronic laminitic claws were documented. The FCS of farm six, five and seven were about 3.5, 4.5 and five times higher compared to farm one. Regarding the distribution of the prevalence data of the different claw lesions within one herd the trained operator is enabled to carry out a risk analysis, attributing for example the high prevalence of WWL in farms five and seven predominantly to nutritional influences due to the even high ≧ 60% prevalence of laminitic claws. In contrary, the heifers of farm four had even a high 97.2% prevalence of WWL, a rather high prevalence of DS with 52.5% and SH with 32.4%, but a rather low 23.5% prevalence of laminitic claws. In this farm, the main causative factor has to be addressed to mechanical and mangement factors and not to the diet.

From an economical point of view, the reported rather high prevalence of claw disorders in young cattle (Frankena et al., 1992; Vermunt and Greenough, 1996; Chaplin et al., 2000; Hoblet et al., 2000; Webster, 2002; Offer et al., 2001, 2003; Drendel et al., 2005; Leach et al., 2005; Capion et al., 2008, 2009) has to be addressed as a very critical situation. However, these heifers are intended to be the future milk producing cows with a preferably high production for many lactations. The costs for breeding of heifers were calculated by Wangler et al. (2006) at an average amount of 1760 € – ranging from 1232–2269 € – per animal in North-Eastern Germany. However, a dairy cow exceeds the break-even point not before the third to fourth lactation, depending on individual farm- and regional milk price conditions (Wangler et al., 2006).

In conclusion, we recommend performing functional claw trimming and documentation of claw lesions already in heifers around the first insemination or at least two months before calving. Bell et al. (2009) addressed this measure as a critical control point for dairy cows to prevent heifers succumbing to claw diseases at the beginning of their first lactation. The same claw lesions such as WLL, HHE, SH, SU and various claw skin lesions as assessed in heifers have been described as the most important claw disorders in lactating cows later on (Clarkson et al., 1996; Chaplin et al., 2000; Hirst et al., 2002; Ettema et al., 2007; Amory et al., 2008; Kujala et al., 2010).

Claw trimming of heifers should be implemented as a regular prophylactic measure for all dairy herds to minimise the described high prevalence of lameness in lactating cows and to get better insight in potential risk factors, especially evaluating the digitally recorded data by the Claw manager analysis system. The risk for development of claw diseases during the first and later lactations may be markedly reduced by the early treatment of lesions (Hoblet et al., 2000; Hirst et al., 2002; Drendel et al., 2005; Capion et al., 2009), by improving housing conditions (Hultgren and Svensson, 2009) and feeding (Offer et al., 2001, 2003; Leach et al., 2005). Therefore, the consideration must be: the basis of good claw health of the dairy herd is grounded in young stock.

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