From the Clinic of Orthopaedics in Large Animals, Department for Horses and Small Animals[1], Institute of Biochemistry, Department of Natural Sciences[2], University of Veterinary Medicine, Vienna, and the Veterinary Practice Gertrude Pesenhofer[3]

Comparison of two methods of fixation during functional claw trimming - walk-in crush versus tilt table - in dairy cows using faecal cortisol metabolite concentrations and daily milk yield as parameters

G. PESENHOFER[1,3], R. PALME[2], R.M. PESENHOFER[3] and J. KOFLER[1]

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Summary

This study compared the effect of functional claw trimming with 2 different types of trimming set-ups, a mobile walk-in crush and a tilt table, on faecal cortisol metabolites (= FCM) of 207 cattle. FCM were measured before and 9, 10, 11, 12, 24, 48 hours and 7 days after trimming. Daily milk yield 7 days prior until 13 days after trimming and evasion movement score in each animal were determined as an indirect measure for stress.

FCM concentrations peaked 9 hours after trimming: cows trimmed in the mobile walk-in crush had a median FCM concentration of 216 nmol/kg (mean: 292 nmol/kg) and those trimmed on the tilt table had a median of 141 nmol/kg (mean: 218 nmol/kg). The values of FCM were significantly higher in cattle trimmed with the walk-in crush ($p<0.001$) until 24 hours after trimming. More time was needed to trim the cows´ feet using the mobile walk-in crush (15.9 ± 4.4 min) compared to the tilt table (11.1 ± 3.5 min; $p<0.001$). In both groups milk yield was 0.6 L lower on the day of claw trimming and the day after.

Cows trimmed with the mobile walk-in crush showed more evasion movements than those trimmed with the tilt table ($p<0.001$), but there was no correlation between the intensity of those movements and concentrations of FCM.

Although claw trimming and associated handling cause stress reactions in cattle, regular claw trimming helps to keep the claws healthy and should be an integral part of improving the welfare of cattle. Our results indicate that claw trimming with a tilt table seems to be less disturbing for the cows.

Abbreviations: CCS = cow claw score; DLG = Deutsche Landwirtschafts-Gesellschaft e.V.; EIA = Enzyme Immunoassay; FCM = faecal cortisol metabolites

Schlüsselwörter: Klauenpflege, Nebennierenaktivität, Stress, Kortisolmetaboliten, Kot, Rind, Tierschutz.

Zusammenfassung

Vergleich zweier Methoden der Fixierung für die funktionelle Klauenpflege - Durchtreibestand und Kippstand - bei Kühen mittels Messung der Kortisolmetabolitenkonzentration im Kot und der täglichen Milchleistung

Der Einfluss der funktionellen Klauenpflege - durchgeführt mit einem Durchtreibestand bzw. einem Kippstand - auf die Konzentration der Kortisolmetaboliten im Kot (=FCM) von 207 Rindern wurde untersucht.

Die FCM Konzentration wurde vor und 9, 10, 11, 12, 24, 48 Stunden sowie 7 Tage nach erfolgter Klauenpflege gemessen. Als weitere indirekte Stressparameter wurden die tägliche Milchleistung beginnend 7 Tage vor Klauenpflege bis 13 Tage nach Klauenpflege und die Abwehrbewegungen (Score 0-3) bei jedem Tier bestimmt.

Der maximale Anstieg der FCM-Konzentration wurde 9 Stunden nach Beendigung der Klauenpflege gemessen. Kühe, die im Durchtreibestand gepflegt worden waren, zeigten einen höheren Anstieg der FCM-Konzentration (Median: 216 nmol/kg Kot), im Vergleich zu den am Kippstand ausgeschnittenen Kühen (Median: 141 nmol/kg Kot). Der FCM-Anstieg war bei Kühen, die im Durchtreibestand gepflegt worden waren, bis 24 Stunden nach der Klauenpflege signifikant höher ($p<0,001$). Die Klauenpflege im Durchtreibestand dauerte signifikant länger (15,9 ± 4,4 min; $p<0.001$) als auf dem Kippstand (11,1 ± 3,5 min).

Die Milchleistung war nur am Tag der Klauenpflege und am Tag danach um 0,6 Liter reduziert, es bestand kein signifikanter Unterschied im Milchmengenrückgang zwischen den Kühen der beiden Gruppen. Kühe, die im Durchtreibestand gepflegt wurden, zeigten höhere Abwehrbewegungs-Scores als jene auf dem Kippstand ($p<0,001$), es konnte jedoch keine Korrelation zwischen der Intensität der Abwehrbewegungen und der FCM-Konzentration nachgewiesen werden.

Obwohl die Klauenpflege und alle damit verbundenen Manipulationen bei Kühen Stressreaktionen auslösen, bleibt die Notwendigkeit einer regelmäßigen Klauenpflege für die Erhaltung der Klauengesundheit unbestritten und stellt damit einen integralen Aspekt der Verbesserung des Wohlbefindens der Rinder dar. Unsere Ergebnisse zeigen, dass die Klauenpflege am Kippstand für die Kühe weniger belastend erscheint.

Introduction

The incidence of claw horn lesions associated with lameness is a major concern in managing modern intensive dairy herds. The resulting discomfort and pain were identified as an important animal welfare issue (CLARKSON et al., 1996; LEACH et al., 1998; LOGUE et al., 1998; OFFER et al., 2000; HERNANDEZ et al., 2002; MANSKE et al., 2002; O'CALLAGHAN, 2002; WHAY et al., 2003; O'CALLAGHAN LOWE et al., 2004). WEBSTER et al. (2004) defined animal welfare as "fit and feeling good", implying a capacity to sustain health and vigour throughout an animal's effective working life. The responsibility for animal welfare should imply more than simply a desire to minimise suffering but incorporate a concern for elements of positive welfare such as comfort, companionship, and security as it is defined by the "Five Freedoms" (FAWC, 1993).

Cattle lameness has a great economic impact on the dairy industry, it is ranked as the third most important disease after mastitis and reproduction disorders (RAJALA-SCHULTZ et al., 1999; GREEN et al., 2002; HERNANDEZ et al., 2002; O'CALLAGHAN, 2002; WINCKLER and BRILL, 2004).

Functional claw trimming is a simple, repeatable method for maintaining physiological biomechanical function of the bovine digit and can avoid the onset of lameness in cattle, preventing claw horn lesions from evolving from a subclinical to the clinical stage (TOUSSAINT-RAVEN, 1989; SHEARER and AMSTEL, 2001; FIEDLER et al., 2004; HUBER et al., 2004; TOL et al., 2004). Functional claw trimming, carried out once or better twice a year according to the Dutch standard (TOUSSAINT-RAVEN, 1989), is now regarded as an integral part of any lameness management and control as well as claw health prophylaxis programme (SHEARER and AMSTEL, 2001, FIEDLER et al., 2004; HUBER et al., 2004). Modern claw trimming requires proper restraint systems for cattle such as walk-in crush or tilt tables (KLOOSTERMAN, 1997; STANEK et al., 1998; SHEARER and AMSTEL, 2001; FIEDLER et al., 2004). That is particularly important when grinding discs are applied, which are prefered by many veterinarians and professional claw trimmers as they work fast and effectively (KLOOSTERMAN, 1997; KOFLER, 2001; SHEARER and AMSTEL, 2001; FIEDLER et al., 2004; JANTSCHER et al., 2005). In Austria hydraulic tilt tables are used frequently, where the cow is placed in lateral recumbency, and all 4 feet can be trimmed easily. The mobile walk-in crush is used also, where the cow remains standing. Which system causes the greater stress or discomfort for the cow is the subject of frequent debate between walk-in crush and tilt table users (SHEARER and AMSTEL, 2001).

Under stress, glucocorticoids are secreted by the adrenal cortex. Their blood concentrations have been used to reflect the effects of various stressors (MÖSTL and PALME, 2002). SIXT et al. (1997) investigated the effect of 2 different methods of claw trimming on plasma cortisol concentrations. However, as blood sampling itself may cause stress, non-invasive methods for evaluating adrenocortical activity may be more accurate for assessing stress reactions in animals (MÖSTL and PALME, 2002). As stress hormones are heavily metabolised in ruminants (PALME and MÖSTL, 1997; EL-BAHR et al., 2005) and thus cortisol itself is not present in the faeces, a group specific enzyme immunoassay (11-oxoaetiocholanolone EIA) has been developed to measure 11,17-dioxoandrostanes, a group of faecal cortisol metabolites. This non-invasive method has been successfully validated and applied in cattle (PALME and MÖSTL, 1997; PALME et al., 1999, 2000; BINDER et al., 2004; PALME, 2005; TOUMA and PALME, 2005).

The objectives of the present study were to investigate the effect of claw trimming in cattle and their restraint in either a mobile walk-in crush and a tilt table on animal's stress reactions using measurements of faecal cortisol metabolites (FCM) and milk yield as parameters.

Material and methods

Animals

This study was carried out on 6 dairy farms in Styria, Austria, from December 2003 to October 2004. During the previous few years the milking cattle had received regular claw trimming by the author (R.M.P.). A total of 207 dairy cattle (201 cows, 6 heifers) was included in the study (90 Holstein Friesian, 84 Simmental and 33 Brown Swiss). Half of the cattle were housed in tie stalls, the rest were kept in loose housing systems. Data were collected for each cow: age, days in lactation, and 305-day milk yield for the previous lactation. The health status of cattle was determined from their rectal temperature, pulse and respiratory rate 12 hours before claw trimming. Cows showing values of these 3 parameters outside the physiological range were excluded from the study.

The milk yield of 178 cows was recorded twice a day for 7 days before until 13 days after claw trimming using flow meters. 57 cows were in the first, 57 cows in the second and 64 cows in the third trimester of lactation. The other 23 cows were in the dry period or their milk yield could not be measured during the complete 21-day period due to parturition.

The cows on each farm were divided randomly into 2 groups: those in group 1 were trimmed using a walk-in crush (n=103), and those in group 2 were restrained on a tilt table (n=104).

Locomotion score was assessed immediately prior to claw trimming. A score of 0 indicated no abnormality of gait, score 1 a slight lameness, score 2 marked lameness, and score 3 a non-weight-bearing lameness.

Restraint and claw trimming

Functional claw trimming was carried out by R.M.P. outside the stable on all the farms. Using the mobile walk-in crush (Top 5, Rosensteiner G.m.b.H, Steinbach/Steyr, Austria) the cow´s head was restrained by a stanchion and the body supported by thoracic and thigh belts (Fig. 1). 2 diagonal feet were tethered with ropes and lifted with a swivel arm. During claw trimming the cow remained in the standing position. The same procedure was repeated with the other 2 legs.

Using the tilt table (Kipp Top, Rosensteiner G.m.b.H., Steinbach/Steyr, Austria) the cow´s head was restrained with a metal neck frame and 3 ropes secured the body. The table was tilted to place the cow into left lateral recumbency. Then all 4 feet were secured with belts placed above the fetlocks. The left front leg was fixed in the most forward position possible to reduce vascular and nerve damage in the shoulder area (Fig. 2). After trimming, the cow was returned to its standing position, the ropes removed, and

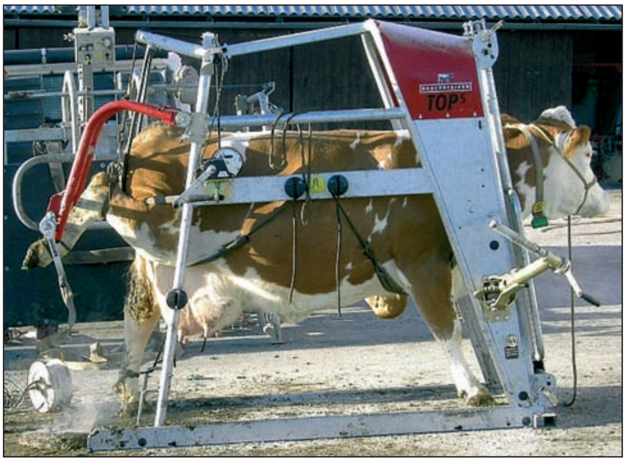

Fig. 1: Cow restrained in standing position in a walk-in crush

Fig. 2: Cow restrained in lateral recumbency on the tilt table

the animal walked away. Both trimming devices are widely used in Middle Europe and were certified for the use in cattle by a DLG-test (German Agricultural Society).

Functional claw trimming was carried out using angle grinders fitted with either a titanium 6 knife grinding disk (Wopa, JV Harreveld, NL), or a 50 % hard metal granulate fitted disk (Harnischmacher GmbH, Fröndenberg, Germany), and a hoof knife. The trimming procedure was carried out according to the Dutch standard (TOUSSAINT-RAVEN, 1989). The time needed to guide the cattle to the set-ups was recorded as well as the time needed for restraining and claw trimming.

The cattle's behaviour throughout the whole period of restraint was described using an evasion score; score 0 indicated quiet acceptance of the procedure, score 1 described occasional movements of the head, score 2 repeated head movements and score 3 persistent and rigorous head movements.

Claw scoring

In order to assess the potential influence of claw lesions on basal FCM concentrations, all 8 weight-bearing claws of each cow were examined for lesions by a single observer (G.P.) after functional claw trimming. The sites of the lesions were drawn on foot maps based on the recommendations of GREENOUGH and VERMUNT (1991), and the severity of lesions was arithmetically and geometrically scored using the claw scoring system described by LEACH et al. (1998). The geometric severity scores for all zones of all 8 claws were added resulting in the "cow claw score" (CCS) for each animal.

Faecal cortisol metabolites

Basal FCM concentrations for each cow were measured in faeces 12 hours before claw trimming. Cortisol response to trimming was measured in fresh faecal samples obtained 9, 10, 11, and 12 hours after trimming, and then 24, 48 hours and 7 days later. The samples were frozen immediately after collection and stored at -20 °C until analysis. For analysis, a 0.5 g portion of faeces was mixed with 5 ml 80 % methanol, shaken and centrifuged. An aliquot of the supernatant was taken and FCM were measured, using an 11-oxoaetiocholanolone EIA (PALME and MÖSTL, 1997; PALME et al., 1999).

Statistical analysis

Statistical analysis was carried using SPSS 12.0 (SPSS Inc., Chicago, Illinois). All FCM values were adjusted by subtraction of the individual basal FCM values. The applied statistical methods are listed in Tab. 1.

Results

Faecal cortisol metabolites

The concentrations of FCM measured in the "baseline samples" before claw trimming varied from 15 nmol/kg - 576 nmol/kg faeces. The median of the cows trimmed with the walk-in crush was 81 nmol/kg (mean: 135) and, of those trimmed with the tilt table 89 nmol/kg (mean: 137). As the values of both groups of claw trimming set-ups did not differ significantly ($p = 0.997$), it was justified to handle both groups as statistically equal.

Cows with a lameness score of 1 (n=12; median: 70 nmol/kg) or 2 (n=12; median: 138 nmol/kg) did not have significantly higher baseline values than those with a lameness score of 0 (n=183; median: 81 nmol/kg).

The cow claw score (CCS) ranged from 0 to 84 (median: 5). Cows with higher cow claw scores did not have higher basal FCM values. No correlation could be found between milk yield and basal values. There was no statistical difference in the baseline values between the cattle from loose housing systems (median: 85 nmol/kg) and cattle from tie stalls (median: 81 nmol/kg).

9 hours after claw trimming the highest FCM values were measured. Cows trimmed with the walk-in crush showed higher increase of FCM concentrations (median: 216 nmol/kg, mean: 292) than those trimmed with the tilt table (median: 141 nmol/kg, mean: 218; Fig. 3; Tab. 2). Statistical analysis showed a significant influence ($p<0.001$) of the type of claw trimming set-up on the FCM values until 24 hours after claw trimming, with significant higher values found in cows trimmed with the walk-in crush (Fig. 3; Tab. 2). No further statistical significant differences in FCM values between the 2 types of trimming set-ups were measured 2 and 7 days after claw trimming.

Time and evasion movements

Significantly less time (11.1 ± 3.5 min) was needed for

Tab. 1: Applied statistical methods; FCM: faecal cortisol metabolites; CCS: cow claw score; [1]according to VERBEKE and MOLENBERGHS (2000)

Independent variable	Effect on	Test chosen
type of claw trimming set-up	FCM increase	linear mixed model[1]
type of claw trimming set-up	milk yield reduction	linear mixed model[1]
daily milk yield prior to trimming	daily milk yield after trimming	Wilcoxon signed rank test
type of claw trimming set-up	time for trimming	Mann-Whitney
type of housing	basal FCM values	Mann-Whitney
lameness score	basal FCM values	Kruskal-Wallis
milk yield	basal FCM values	Spearman correlation coefficient
CCS	basal FCM values	Spearman correlation coefficient
FCM increase	milk yield reduction	Spearman correlation coefficient
type of claw trimming set-up	evasion movements	Chi-square

Tab. 2: Increase of FCM concentrations (nmol/kg faeces) of cattle trimmed with the walk-in crush (n=103) and cattle trimmed with the tilt table (n=104) at different times after claw trimming

	Walk-in-crush		Tilt table	
	mean	median	mean	median
9 hours	292	216	218	141
10 hours	229	186	151	103
11 hours	201	159	119	95
12 hours	155	119	107	74
24 hours	107	75	83	87
48 hours	49	36	25	32
7 days	48	20	9	30

claw trimming using the tilt table than with the mobile walk-in crush (15.9 ± 4.9 min; p<0.001). These time measures included the total period necessary for the claw trimming procedure beginning from haltering of the animal until the end of claw trimming. The time needed only for haltering and leading the cattle to the trimming set-up and for fixation in/on the device was as follows: 3 min (n=174), 5 min (n=26), 6 min (n=3), 8 min (n=1) and 10 (n=3). A total of 200 out of 207 animals were restrained within 5 minutes.

Cattle trimmed on the tilt table showed significantly fewer evasion movements too (p<0.001). 146 cows (70.5 %) exhibited no evasion movements (score 0), 15 cows had an evasion movement score of 1, 32 had a score of 2 and 14 cattle had a score of 3. Cows, trimmed with the mobile-in crush had a shift to higher scores (score 2 and 3; Fig. 4). Evasion movement scores did not correlate with FCM levels.

Daily milk yield

Average milk production of the 305-day lactation period of all cows in the 6 herds was 7,881 kg. During the pre-trimming period of 7 days the median of daily milk yield was 23.6 litres. The lowest daily milk yield was measured 5 days before (median: 23.0), the highest daily milk yield the day before claw trimming (median: 25.0). At the day of claw trimming the median milk yield was 23.1, reduced by 0.5 L compared to the prior 7-day median. The day after claw trimming the median of milk yield was 23.0 (-0.6 L), which was the lowest daily milk yield measured after claw trimming (Fig. 5). The non-parametric Wilcoxon signed rank test showed that the milk yield reduction was significant on the day of claw trimming and one day after. No statistical difference in daily milk yield could be found comparing the 2 types of claw trimming set-ups. Higher increases of FCM in cows were not correlated with a greater reduction of daily milk yield.

Discussion

Although claw trimming normally is a safe procedure for the cattle, injuries can be caused during this procedure by claw trimmers, due to evasion movements and pressure problems of underlying muscles, when too much time is needed for paring off the claws. Furthermore, animals can potentially sustain injuries on the way to the trimming set-up, in the set-up especially when grinding discs are used, and on the way from the set-up back to the stable (KOFLER, 2001; SHEARER and AMSTEL, 2001). The claw trimming procedure itself contains many possibilities to induce stress reactions in cows: an interruption of the daily routine, the handling of the cattle in the immediate pre-trimming phase, the restraint procedure and the claw trimming itself with optical, acoustical, tactile and mechanical disturbances (STANEK et al., 1998).

To evaluate the stress reactions of cows during the procedure of claw trimming, cortisol metabolites were measured in the faeces. This method has proved to be suitable for monitoring adrenocortical activity and thus disturbances in ruminants (PALME and MÖSTL, 1997; PALME et al., 1999, 2000). Unlike blood, faecal samples offer the advantage that they can be collected easily and non-invasively, thus avoiding additional stress (MÖSTL and PALME, 2002; BINDER et al., 2004; TOUMA and PALME, 2005).

To compare the values of FCM between the groups the first sample was taken before claw trimming. Individual baseline values differed from 15 to 576 nmol/kg faeces.

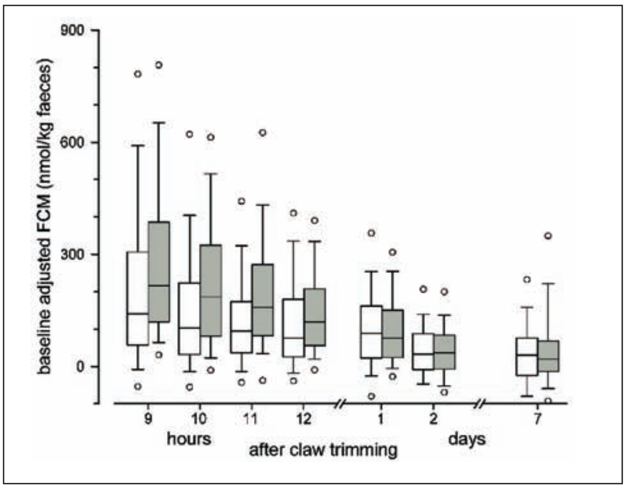

Fig. 3: Boxplot diagram showing the baseline adjusted values of concentrations of faecal cortisol metabolites (FCM) for cows trimmed with the tilt table (white boxes) and the mobile walk-in-crush (grey boxes); the bold line within the boxes indicates the median value. The length of the boxes equals the interquartile range, 50 percent of the values lie within. The whiskers show the 10th and 90th percentiles of the values of faecal samples. The circles represent the 5th and 95th percentiles.

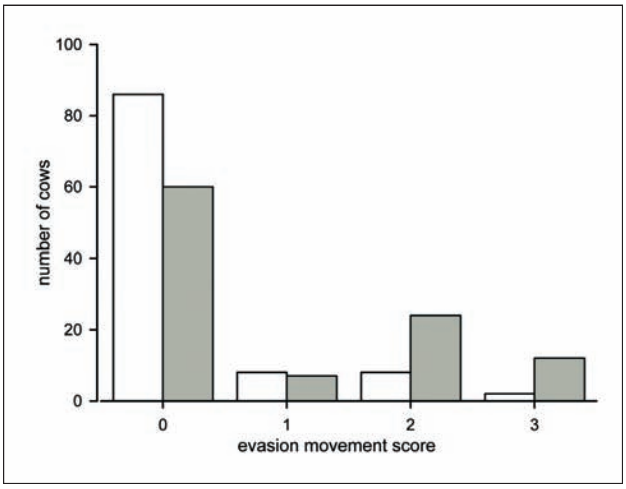

Fig. 4: The bar graph shows the numbers of cows trimmed with the tilt table (white bars) and the mobile walk-in-crush (grey bars), showing different intensity of evasion movements (score).

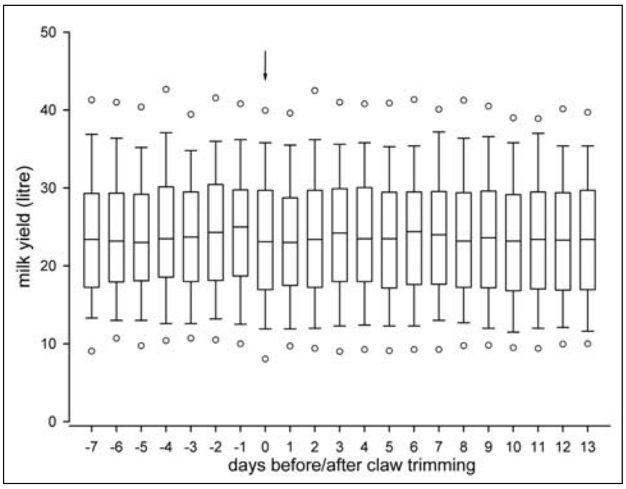

Fig. 5: Boxplot diagram of daily milk yield of 178 cows beginning 7 days before until 13 days after claw trimming; arrow indicates day of claw trimming.

The median baseline FCM values of the 2 groups of cows trimmed by 2 different trimming set-ups (81 nmol/kg and 89 nmol/kg, respectively) were not significantly different. PALME et al. (1999) measured baseline FCM values from 34 and 445 nmol/kg and, in another study (PALME et al., 2000) the basal concentrations ranged from 51 to 282 nmol/kg. Thus, there seems to be a wide individual variation in basal FCM values, nevertheless median values were about the same level in all these studies (88 to 99 nmol/kg; PALME et al., 1999, 2000).

In previous studies, the peak concentrations of FCM were reported to occur between 9 and 12 hours after the stressful event (PALME et al., 1999, 2000). Therefore we decided to collect the first faecal sample 9 hours after claw trimming. The highest increase of FCM concentration was obtained in those samples (median: 141 nmol/kg and 216 nmol/kg), and then the values decreased by every hour. The increase in FCM after the claw trimming procedure was low compared with the increase in FCM of cattle that were transported for 2 hours. In the latter a median of 876 nmol/kg was measured 12 hours after transport (PALME et al., 2000).

In our study, cows were exposed to a stressful situation for a much shorter time, so the shortness of the intensive interaction might be one possible explanation for finding maximum concentrations of FCM already 9 hours afterwards. A significant difference of FCM concentration was observed until 24 hours after trimming, when comparing the 2 types of claw trimming set-ups. Cows trimmed with the tilt table had significantly lower concentrations of FCM than cows that remained standing during claw trimming in the walk-in crush. The claw trimming procedure using the tilt table required significantly less time than using the walk-in crush.

No differences in FCM baseline values were found between cattle from loose housing systems and cattle from tie stalls. Only a small number (n=24) of lame cows with lameness score 1 and 2 were involved in the present study: these slightly and moderately lame cows showed no significant higher FCM baseline values than non-lame cattle. This is in accordance with results from LEY et al. (1996), who did not find significant differences of plasma cortisol concentrations between sound and chronically lame cows, but the score of the observed lameness was not reported.

The cows investigated in this study had a low cow claw score with 40 cows exhibiting no claw lesions. However, it has to be mentioned that all these farms have their cows trimmed routinely once or twice a year resulting in overall good claw health.

SIXT et al. (1997) and STANEK et al. (1998) compared 2 types of claw trimming set-ups by measuring plasma cortisol concentrations and FCM concentrations (STANEK et al., 1998) respectively. They found no differences between the 2 set-ups. The time needed to trim the claws was considerably longer (30 to 55 minutes) compared to the present study, and no significant difference between the 2 set-ups was found. A period of 11 to approximately 16 minutes for trimming one cow is a rather short time, particularly when the time for haltering and fixation of the cow is included. We separately measured both the time necessary for restraining cattle - this procedure took 5 min or less in 200 cows - and the time needed for the claw trimming procedure itself. However, it was not possible to differentiate the effect of these 2 different but immediately subsequent manipulations on the FCM concentration.

The tilt table appeared preferable to the human observer. The animal being properly fixed lays more quietly, whilst in the walk-in crush the cows seemed to rest less comfortable with lifted legs. Cows trimmed with the tilt table showed less evasion movements. However, cows with higher levels of FCM did not show more evasion reactions. The reason might be that the animals lying on the tilt table and being secured with all 4 feet have less freedom of movement than those standing on 2 feet in a crush, where only 2 limbs are restrained. Comparing our results to similar studies (SIXT et al., 1997; STANEK et al., 1998) we hypothesize that the time of restraint exerts a larger influence on stress reactions of cattle than the type of claw trimming set-up used.

Ineffective restraint allows more freedom for the cow to resist, and this might be falsely interpreted as pain and stress related behaviour (O'CALLAGHAN LOWE et al., 2004). O'CALLAGHAN LOWE et al. (2004) compared the working practice of claw trimmers and veterinary orthopaedic surgeons: most claw trimmers believed that routine foot trimming was neither stressful nor painful, a significantly higher proportion of veterinary surgeons considered both preventive foot trimming and treating claw lesions to be potentially painful and stressful. This perception might have been distorted by the fact that 88 % of the veterinary respondents relied on farm facilities only and probably the use of local anaesthesia to restrain the cattle while attending to their feet. Many farms however lack the special facilities designed to restrain lame cows for claw trimming. On the other hand, claw trimmers used their own specifically designed equipment to restrain cattle effectively during claw care (O'CALLAGHAN LOWE et al., 2004). Well designed restraining devices have the potential to reduce stress experienced by the cow (GRANDIN, 1998). The animal must be held tightly enough to provide a feeling of restraint, while avoiding pain caused by excessive pressure. Leading cattle slowly and carefully from the yards to the processing area can also reduce the amount of stress. Restraint can be a very strong source of stress. Training cattle to accept handling procedures and facilities can help to reduce this type of stress. The animal's perception of a stressful event is influenced by its previous individual handling experience, individual genetics, individual age and its physiologic state at the time at which it is exposed to the stress (ZAVY et al., 1992; GRANDIN, 1998).

In the present study, daily milk yield was only slightly reduced at the day of claw trimming and one day after by 0.6 L. From the second day after claw trimming on the daily milk yield had recovered to its original value. THONHAUSER et al. (1994) measured the daily milk yield of cows 7 days prior until 22 days after claw trimming. During the 22-day period after claw trimming a reduction of about 10 % was found. In that study the whole claw trimming procedure in the herd took 4 days and was carried out in the stable, also disturbing animals not involved in the trimming procedure at this time. In the study of THONHAUSER et al. (1994), a pre-trimming reduction of milk yield could be observed also in those cows that were trimmed not before the second, third or fourth day. From this we can assume that the handling and change in environment with acoustic and physical disturbances in the stable agitated the cows potentially explaining the negative influence on milk yield. Since GRANDIN (1998) reported that cattle have very sensitive hearing, especially at high frequencies, handling facilities and equipment should be designed to avoid clanging and banging, and the hydraulic system of trimming chutes should be engineered to be quiet.

A study on the effects of digital disease on milk production reported a milk loss in cows with foot disorders that varied between 1.5 and 2.8 kg per day during the first 2 weeks after lameness was diagnosed (RAJALA-SCHULTZ et al., 1999). HERNANDEZ et al. (2002) found an approximately 10 % decrease in mean milk production in 167 lame cows from a total of 531 lactating cows during the 305 day period. The significant impact on milk yield reduction of clinically lame cows was estimated at 357 kg per 305 day lactation, and in these lame cows milk yield was reduced from up to 4 months before lameness was diagnosed and treated until 5 months after treatment (GREEN et al., 2002).

Comparing these studies with the present study, restraint and claw trimming time appeared to be crucial for the development of stress related milk yield reduction. In this study, the daily milk yield reduction was very small and very short, and also the time needed for the complete claw trimming procedure with a mean of <16 minutes was very short. This demonstrates that the short-term, small reduction of milk yield after claw trimming is by far preferable to longer periods of milk yield losses caused by lameness (GREEN et al., 2002; HERNANDEZ et al., 2002). Therefore, functional claw trimming performed 2 to 3 times a year should be strongly recommended to the farmers as an integral part of any dairy herd management and control program.

In the present study, the hypothesis that the claw trimming procedure causes an increase of FCM concentrations was confirmed, but the maximum levels measured were much lower than described in other studies for other stressors (PALME et al., 2000). The elevation of the FCM concentration was significantly higher in cows trimmed with a walk-in crush than with a tilt table. This fact together with a higher evasion score and a longer time needed to trim the cattle in the walk-in crush renders the tilt table less disturbing and therefore better suited for claw trimming. Although claw trimming and associated handling causes stress reactions in cattle, the necessity of regular claw trimming to ensure healthy claws and prevent lameness is clear, and it is therefore an integral part of improving the welfare of cattle. In order to minimise stress reactions, claw trimming must be done carefully and quickly, and in a suitable environment. Therefore cows have to be restrained safely and correctly using specifically designed and certificated equipment.

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Authors' address:
Dr. Gertrude Pesenhofer, Univ. Prof. Dr. Rupert Palme, Univ. Prof. Dr. Johann Kofler, Veterinärplatz 1, A-1210 Vienna; Dr. Gertrude Pesenhofer, Robert M. Pesenhofer, A - 8151 Hitzendorf/Graz.
e-Mail: johann.kofler@vu-wien.ac.at