On the development of asymmetry between lateral and medial rear claws in dairy cows

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Introduction

Claw health problems in modern dairy production become more common with increased use of cubicle systems compared to tie stall systems (Bergsten and Herlin, 1996). Claw disorders are believed to be the main cause of lameness (Murray et al., 1996) and are therefore an issue for both animals' sustainable function within the management system and for animal welfare. Claw conformation may have an influence on the susceptibility for claw disorders (Distl et al., 1990). The housing system can influence claw conformation and over-wear can result in irreversible injuries. The rear outer claw is more prone to overgrowth and is almost always somewhat larger than the rear inner claw. This may be an explanation why the outer claw of rear limbs is much more frequently affected by laminitis related diseases, such as sole ulcers and sole haemorrhages, than other claws (Smits, Frankena et al. 1992). One reason for that asymmetry could be a difference in length of the metatarsal condyles (Nacambo et al., 2004). Another may be differences in growth and wear between claws when the animal is exposed for different flooring conditions whilst walking or standing.

The aim of the study was to assess the effect of different flooring systems on the rate of growth and wear of outer and inner rear claws respectively, that may contribute to an asymmetry between them.

Material and methods

The rate of growth and wear of the rear claws was studied during one housing season in 120 Swedish Holstein cows kept in five different flooring systems in a cubicle herd but otherwise with identical management.

The flooring systems were solid, acid-resistant mastic asphalt with and without feed-stalls, continuous elastic rubber mats (KURA-P ™) with and without feed-stalls and slatted concrete floor without feed-stalls. The feed-stalls were equipped with solid rubber mats. All the solid floors were scraped eleven times per day. The alley to the milking parlour, where all animals passed two times daily was made of concrete slats and the holding pen was made of solid concrete. All animals´ feet were bathed daily when passing a nylon coated foam mat with copper sulphate solution.

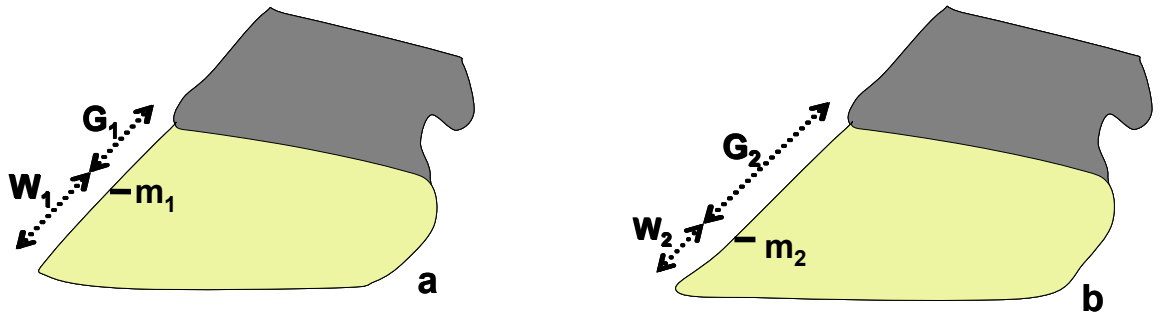
Claw growth and wear were measured over a 4-month period by measuring the distal displacement of a mark which had been burnt on the dorsal and abaxial wall of the outer and inner claw of the left rear leg at the start of the study.

A general linear model procedure was used to analyze the data (JMP, Version 5, SAS Inst.). The model included lactation number, flooring system and their interaction. Lactation stage (days in milk) was used as a covariate. The Tukey HSD test was applied for multiple

comparisons between different floorings. The paired t-test was used to compare outer and inner claws within flooring system.

Figure 1. Claw wall growth and wear were measured over a 4-month period after calving, by measuring the distal displacement of a burnt mark = m: a – the claw at the first examination, b – after 4 months.

Growth = G2 - G1; Wear = W1 - W2



Results

The highest abrasion rate of the dorsal wall (toe), differing significantly from the other groups, was that on asphalt flooring without feed-stalls (Tab. 1). When feed-stalls were used together with the asphalt floor, the claw wear was significantly reduced. The cows kept on rubber mats had the least wear of the dorsal wall, but it did not differ significantly from that on slatted concrete flooring. The largest claw horn growth of the dorsal wall was recorded in cows on asphalt floor without feed-stalls.

There were no differences in the rate of toe-growth between outer and inner claws on either of the floorings except for asphalt flooring without feed-stalls, where the toe-growth of the inner claws exceeded that of the outer claws. However, the asphalt flooring without feed-stalls was the only system where the wear of the inner toe was not significantly larger than of that on the outer toe. The net growth of the dorsal wall was larger in outer claws on all floorings except for asphalt floors without feed-stalls.

Table 1. Rate of growth and wear of the dorsal wall of the claws of the left hind limb (mm/month)

Flooring system	Growth of outer claw		Growth of inner claw		Wear of outer claw		Wear of inner claw		Net growth of outer claw		Net growth of inner claw	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Slatted concrete without feed-stalls	4.09 $^{a\,b}$	0.35	4.34 ^{a}	0.31	*1.55* ^{a}	0.31	*2.98* ^{a}	0.33	*2.54*^{a}	0.37	*1.36*$^{a,\,c}$	0.32
Asphalt floor without feed-stalls	*5.12* ^{a}	0.36	*5.83* ^{b}	0.31	5.30 ^{b}	0.31	5.95 ^{b}	0.33	-0.18^{b}	0.37	-0.12^{b}	0.32
Asphalt floor with feed-stalls	4.46 $^{a\,b}$	0.35	4.78 ^{a}	0.30	*3.29* ^{c}	0.31	*4.10* ^{c}	0.32	*1.16*^{c}	0.36	*0.68*^{a,b}	0.31
Rubber floor without feed-stalls	3.78 ^{b}	0.33	3.91 ^{a}	0.29	*1.33* ^{a}	0.29	*1.93* ^{d}	0.30	*2.45*^{a}	0.34	*1.97*^{c}	0.29
Rubber floor with feed-stalls	3.88 ^{b}	0.35	3.97 ^{a}	0.31	*1.42* ^{a}	0.31	*2.12* $^{a,\,d}$	0.32	*2.48*^{a}	0.37	*1.85*^{c}	0.32

Growth and wear rates within columns with different letters differ significantly at $P<0.05$

Growth and wear rates of claws within foot (outer/inner) within the same flooring system marked with italic differ significantly at $P<0.05$

Both asphalt flooring systems caused more wear of the abaxial (outer side) wall in outer and inner claws than did the other flooring systems (Tab. 2). Moreover, a significantly larger growth of the abaxial wall of both inner and outer claws was seen in animals kept on asphalt floor without feed-stalls than in the group on rubber floors without feed-stalls. The growth of the abaxial outer claw wall exceeded significantly that of the inner claw only in groups with asphalt floor without feed-stalls and in the group on rubber mats with feed-stalls. The net growth of abaxial wall was larger of the outer claw than of the inner claw in all animals but a significant difference was only obtained in the groups with asphalt and rubber flooring with feed-stalls and with slatted concrete flooring.

Table 2. Rate of growth and wear of the abaxial wall of the claws of the left hind limb (mm/month)

Flooring system	Growth of outer claw		Growth of inner claw		Wear of outer claw		Wear of inner claw		Net growth of outer claw		Net growth of inner claw	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Slatted concrete without feed-stalls	4.91 [a, b]	0.23	4.40 [a, b]	0.22	1.94 [a]	0.24	2.13 [a]	0.22	*2.97* [*a*]	0.29	*2.26* [*a, b*]	0.26
Asphalt floor without feed-stalls	*5.62* [*a*]	0.23	*4.86* [*a*]	0.21	*3.79* [*b*]	0.24	*3.18* [*b*]	0.22	1.83 [b]	0.28	1.67 [b, c]	0.26
Asphalt floor with feed-stalls	4.96 [a, b]	0.23	4.60 [a, b]	0.22	2.88 [c]	0.24	3.27 [b]	0.28	*2.08* [*a. b*]	0.32	*1.33* [*c*]	0.29
Rubber floor without feed-stalls	4.47 [b]	0.23	3.94 [b]	0.24	1.74 [a]	0.28	1.61 [a]	0.27	2.73 [a. b]	0.28	2.33 [a, b]	0.26
Rubber floor with feed-stalls	*4.88* [*a, b*]	0.24	*4.00* [*a, b*]	0.21	1.86 [a]	0.25	1.84 [a]	0.23	*3.01* [a]	0.30	*2.16* [*a*]	0.27

Growth and wear rates within columns with different letters differ significantly at $P<0.05$

Growth and wear rates of claws within foot (outer/inner) within the same flooring system marked with italic differ significantly at $P<0.05$

Discussion

The growth and wear rate of the claws was greatly affected by the flooring system. The growth and wear rate of the dorsal wall revealed larger differences than those of the abaxial wall in the studied flooring systems. Walking and standing at the feed bunk on the asphalt flooring without feed stalls, caused larger wear and growth of the claw horn than in the other systems. Using feed-stalls with rubber mats in combination with the asphalt floor reduced wear and growth rate of the dorsal wall. Excessive wear of the dorsal wall can be explained by a posture adopted by the animals standing in front of the feed bunk to reach feed. Animals trying to reach feed put more load on the toe of the claw and on the asphalt they wore more of the dorsal wall than they did when feed-stalls with rubber mats were used. It seems that some years old concrete, did not contribute much to claw horn wear because there was almost no difference in claw horn growth and wear between slatted concrete floor and floors with rubber flooring.

A positive association between claw horn growth and wear was found in previous studies (Vokey et al., 2001) and might be interpreted as claw growth is positively associated with wear (Hahn et al., 1986). However significantly greater toe-wear in inner claws resulted in a significant growth difference between inner and outer toes only in cows kept on asphalt without feed-stalls. This response stabilized the ratio between growth and wear and cows from that group had no difference in net growth between outer and inner claws.

The difference in wear rate of the abaxial wall between flooring systems was similar to that of the dorsal wall. However, the wear of the inner claw was not larger in the abaxial wall. Moreover, the abaxial wall in the outer claws wore more rapidly in cows on asphalt flooring without feed-stalls.

Conclusions

It was concluded that asphalt floors caused a large wear of the rear claws, which resulted in a more rapid growth rate of the horn. The abrasion from mastic asphalt can appreciated to be similar to a newly made concrete floor. Rubber mats on walking areas and feed places reduced both wear and growth of the claw horn. The claw horn growth and wear on a couple of years aged, smooth concrete, slatted floor did not differ from that of rubber flooring.

In all the systems, the wear of the dorsal wall (toe) was significantly larger in the inner claws than in the outer claws, which generally explains the presence of longer outer toes. In contrast, higher net growth of the abaxial wall than in the dorsal wall in the outer claws on asphalt was explained by a lower wear of these claws.

Further studies are under progress to study the influence of flooring system on sole profile and pressure distribution between and within claws, and associations with locomotion and claw lesions.

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