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Alteration of claw dimensions in dairy cows affected with laminitis related sole lesions#

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Abstract

This study was conducted among 18 lactating crossbred cows that had clinical lameness associated with painful sole lesions. Claw dimensions were recorded using standard techniques from affected claws in selected animals before functional hoof trimming and compared with standard values. A significant ($p < 0.01$) increase in the toe height and claw diagonal of the affected claws of selected animals was observed when compared to the standard values. Toe angle and heel height were significantly ($p < 0.01$) lower when compared to the standard values. No significant changes could be recognised in the toe length of the affected claws. Functional hoof trimming revealed laminitis related sole lesions like sole ulcers and white line which caused lameness in selected animals.

Keywords: *Claw dimensions, sole ulcer, dairy cattle*

Claw dimensions are a crucial consideration when selecting dairy cattle since these can impact milk production and fertility. Defective claw dimensions can change normal standing and resting behaviour which increases the risk of hoof disorders. Hoof disorders can cause clinical lameness in dairy cattle depending on the severity of the hoof lesion. In addition to health and production concerns, hoof ailments pose serious welfare issues in dairy cattle management. Claw biometric analysis of the hoof diseases in dairy cattle (Singh *et al.,*1992 ; Anees, 2019) and culled breeding bulls (Philip *et al.,* 2019) were reported previously. The present study attempted

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to evaluate the claw dimensions in lactating dairy cattle affected with laminitis related sole lesions.

Materials and methods

The study was conducted among 18 lactating crossbred dairy cows aged between three and 10 years with clinical lameness and managed at the University Livestock Farm and Fodder Research and Development Scheme, Mannuthy. Selected animals were restrained in a conventional hoof trimming crush for evaluation of claw measurements and clinical assessment of hoof lesions. Before examination, the claws were brushed and cleaned. Toe length, toe height, toe angle, claw diagonal and heel height measurements of (Fig. 1 to 4) the commonly affected rear lateral claws were made using the procedure described by Philip (2018). Toe length was measured along the dorsal border from the tip of the toe to the proximal end of the claw capsule at the coronary band, using a digital sliding caliper (Carbon fiber composite digital caliper, RoHs, Karnataka). Toe height (cm) was measured at the abaxial wall as the distance between the dorsal skin - horn junction (periople) and the sole - wall border. The toe angle was measured as the angle formed between proximal part of the dorsal border near the tip of the toe and the sole surface with a goniometer (Hochste, Tamilnadu). The diagonal of the hoof was measured from the distal end of the dorsal wall to the highest point of the heel. The height of the heel was measured along a line perpendicular to an imaginary caudal extension of the sole to the highest point of the heel. The recorded claw dimensions were statistically analysed by one-sample t test. Optimum dimensions (Greenough, 2007) of toe length (7.5 cm), toe height (6.0 cm), toe angle (45^0), claw diagonal (12 cm) and heel height (3 cm) were used for statistical analysis. Following claw measurements, the affected claws were evaluated by functional hoof trimming according to the 'Dutch 5-step method' (Raven, 1985) and sole lesions were recorded.

Results and discussion

The mean ± SE values of toe length (cm) in the affected claws were recorded as 7.72 ± 0.25. There was no significant (p= 0.305) difference in toe length of the affected claws of the selected animals when compared to the standard value of 7.5 cm. The mean ± SE values of 6.92 ± 0.18 was observed as toe height (cm) in the affected claws. A significant ($p < 0.01$) increase in the toe height of affected claws was noted when compared to the standard value of 6.8. The mean ± SE values of toe angle (deg) in the affected claws were recorded as 42.51 ± 1.62 and these values were significantly ($p< 0.05$) lower when compared to the standard value of 45 degree. The claw diagonal (cm) of affected claws had a mean ± SE value of 12.76 ± 0.39. There was a significant ($p< 0.05$) increase in toe length of affected claws of the selected animals when compared to the standard value of 12.6 cm. The mean ± SE values of 1.97 ± 0.15 was observed as heel height (cm) in the affected claws. A significantly ($p< 0.05$) lower heel height of affected claws was observed when compared to the standard value of 3.0 cm. Measurements of toe length, toe height, toe angle, claw diagonal and heel height are presented in Table. 1.

Laminitis causes abnormal hoof overgrowth that leads to conformation changes and lameness in cattle. Lame animals tend to exhibit reduced productivity and fertility (Sprecher *et al.,*1997) which has economic consequences in the dairy industry. The mean values of toe length were 7.72 ± 0.25 (cm) for the affected claw and a significant difference

Table. 1. Claw dimensions (Mean ± SE) of affected claws in animals with sole lesions (n=18)

Parameter	Affected claw	Standard value	t value	p value
Toe length (cm)	7.72 ± 0.25 ^{ns}	7.5	1.14	0.305
Toe height (cm)	6.92 ± 0.18**	6.8	5.89	0.002
Toe angle (degree)	42.51 ± 1.62**	45	-4.79	0.005
Claw diagonal (cm)	12.76 ± 0.39**	12.0	4.60	0.006
Heel height (cm)	1.97 ± 0.15**	3.0	-5.67	0.002

*** significant at 0.01 level on one sample t test*

Fig. 1. Toe height

Fig. 2. Toe angle

Fig. 3. Claw diagonal

Fig. 4. Heel height

was not observed from the normal value of 7.5 cm. Toe length is permissible up to 8 mm (Raven,1985) in hind feet of normal Holstein Friesian cows and it increased significantly with age (Nuss and Paulus, 2006). An increased toe length of greater than 8.5 cm in the lateral claws of the deformed overgrown hoof has been reported (Raulkar *et al.,* 2016) in sole affections. The statistically significant increase in toe height of 6.92 ± 0.18 cm in the affected claws was attributed to an overgrowth of the hoof wall and reduction in heel height and resultant changes in hoof dimensions. This is in accordance with Somers *et al.* (2005) who reported a claw height of 6.8 cm in dairy cattle reared on concrete flooring.

The toe angle of 45 to 50 degrees is preferred for dairy cattle and it declined significantly with age (Nuss and Paulus, 2006; Mohamadnia and Khaghani, 2013). A significantly lower toe angle of 42.51 ± 1.62 degrees was recorded in the affected claws and similar hoof angles were documented by Raulkar *et al.* (2016) in their study in dairy cows having uneven weight-bearing due to hoof disorders. The claw diagonal measurement included a combination of both claw angle and toe length. A higher claw diagonal in the affected claws may be due to significant differences in other claw dimensions like toe angle, toe length and heel height.

Measurement of heel depth has received attention in recent studies in the assessment of hoof dimensions. The desired heel height is considered to be 3.8 cm and this depth has been correlated with high milk production in the first lactation. The significantly lower value of heel height in the present study is in agreement with Radišić *et al.* (2012) who reported a lesser heel height and attributed it to an increase in body mass and overload of the hooves. The cows that spent long hours standing on concrete floors also had a likelihood of a reduction in heel depth (Galindo and Broom, 2000). Reduction in heel height was also attributed to a reduction in digital cushion thickness due to lower body condition scores in postpartum cows (Bicalho *et al.,* 2009), that might have exacerbated the lameness due to sole lesions (Mohamadnia and Khaghani,2013). The mean heel height in the lateral claws was slightly lower than the measurements of the medial claws (Philip, 2018). Kibar and Çağlayan (2016) observed that hoof trimming could improve near-normal hoof angle.

Sole haemorrhages and sole ulcers of bovine claws were caused by laminitis (Bergsten, 1994) and similarly sole ulcer and whiteline disease were identified as the laminitis related lesions in the present study by therapeutic hoof trimming (Greenough, 2007). This is in agreement with observations of Kujala *et al.* (2010) who opined that the most common hoof lesions were sole ulcers, white line diseases and sole haemorrhages.

Conclusion

Alterations in claw dimensions in clinically lame cows due to the presence of laminitis related lesions on the sole region are reported in this study. Preventive trimming will help to maintain standard hoof dimensions and to detect the claw lesions eartly for achieving optimum production in dairy cattle.

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Conflict of interest

The authors declare that they have no conflict of interest.

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