

Claw horn growth and wear rates, toe length, and claw size in commercial pigs: A pilot study

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Summary

Mean claw horn growth and wear rates in three commercial gilts were greater for rear feet and for the caudal wall. Outer and inner claws differed in size for rear feet, but not for front feet. Lesions occurred mainly in the outer claws of rear feet.

Keywords: swine, hoof growth and wear rates, toe length, hoof size

Received: January 14, 2010

Accepted: April 23, 2010

Resumen - Índices de crecimiento y desgaste de la pezuña y largo y tamaño de la pezuña en cerdos comerciales: Un estudio piloto

Los índices de desgaste y promedio de crecimiento de la pezuña de primerizas en tres granjas comerciales fueron mayores en las patas traseras y en la pared caudal. Las pezuñas externas e internas difirieron en tamaño en las patas traseras, pero no en las patas delanteras. Las lesiones ocurrieron principalmente en las pezuñas exteriores de las patas traseras.

Résumé - Croissance et degré d'usure de la corne des onglons, longueur des orteils, et taille des onglons chez des porcs commerciaux: Étude pilote

La croissance moyenne et le degré d'usure de la corne des onglons chez trois cochettes d'un élevage commercial étaient plus importants pour les pieds arrière et pour la paroi caudale. Il y avait une différence de taille entre les onglons internes et externes pour les pieds arrière mais pas pour les pieds avant. Les lésions étaient plus fréquentes aux onglons externes des pieds arrière.

Lameness in commercial swine is an important economic and welfare problem.¹ The risk factors for lameness are multifactorial and include nutrition, poor horn quality, trauma, infection, type of housing, and walking surface. Increased incidence of claw horn lesions and lameness has been documented in pigs kept on concrete slats or rough concrete floors.² A relationship between claw horn growth and flooring has been demonstrated.³ The objectives of this study were to investigate horn growth and wear in gilts exposed to concrete flooring, to measure changes in the size of individual claws, and to document the presence and progression of horn lesions in individual claws.

Materials and methods

This project was approved by the Animal Care and Use Committee of the University of Tennessee.

Three 113- to 150-kg commercial crossbred gilts were housed as a group in a 3.0 × 4.4-m pen with access to a concrete walkway. At the beginning of the trial, the pigs were

anesthetized using the following protocol. Anesthesia was induced with midazolam (Hospira, Inc, Lake Forest, Illinois; 0.1 mg per kg), xylazine (Vedco, Inc, St Joseph, Missouri; 2 mg per kg), and ketamine (Fort Dodge Animal Health, Fort Dodge, Iowa; 10 mg per kg), administered IM in combination. When an appropriate level of anesthesia was attained, the trachea was intubated and anesthesia was maintained with isoflurane (Abbott Laboratories, Chicago, Illinois) in oxygen, delivered from a circle system attached to a small animal anesthetic machine (North American Drager, Telford, Pennsylvania). Pigs were ventilated to maintain normocapnia. The end-tidal isoflurane concentration and end-tidal partial pressure of carbon dioxide were monitored continuously with an infrared sidestream gas analyzer (Patient monitor, model 1100; Criticare Systems Inc, Waukesha, Wisconsin).

The feet of all three pigs were examined for claw horn lesions and each foot was given a lesion score on a scale of 1 to 3: 1 = mild, 2 = moderate, and 3 = severe. A line of fine

pricks was made using a 20-gauge hypodermic needle along the coronary band just above the skin and horn junction of each claw on all four feet of each pig. Using a gauze sponge, Indian ink was rubbed into the skin where the needle pricks had been made. The abaxial wall of each of the eight claws was then grooved horizontally and vertically using a power file (Figure 1). Care was taken to ensure that the depth of the grooves did not extend through the full thickness of the wall. The horizontal groove was made close to the periople (skin-horn junction) of the coronary band. Two vertical grooves were made from the horizontal line to the weight-bearing surface on the abaxial wall. The first groove was a short distance behind the toe (defined as the dorsal aspect of the claw at the junction of the abaxial and axial walls) to represent the cranial segment of the abaxial wall (Figure 1). The second vertical groove was just in front of the wall-heel junction to represent the caudal segment of the abaxial wall (Figure 1). Toe length (mm) from the periople to the bearing surface was measured using digital calipers (Figure 2). Claw horn size (mm²) was expressed as (claw width × claw diagonal). Claw width (mm) was measured at the sole-heel junction (Figure 3), and claw diagonal was the distance from the toe to the coronet at the level of the wall-heel junction (Figure 2). Measurements were made at the start of the trial and after 5,

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This article is available online at <http://www.aasv.org/shap.html>.

van Amstel S, Doherty T. Claw horn growth and wear rates, toe length, and claw size in commercial pigs: A pilot study. *J Swine Health Prod.* 2010;18(5):239–243.

19, and 55 days. For the measurements on Days 5, 19, and 55, pigs were raised in a hydraulic chute without sedation (FeetFirst sow chute; Zinpro Performance Minerals, Eden Prairie, Minnesota).

Using digital calipers, the following measurements were made (accurate to 0.1 mm): from the tattoo to the horizontal groove at the junction of the vertical grooves (A and B) and (C and D), and from the horizontal groove along the vertical groove to the bearing surface (E and F) and (G and H) (Figure 1). The extent of growth was calculated from the value of (B - A) for the cranial wall segment and (D - C) for the caudal wall segment. The extent of wear for the cranial wall segment was calculated as the value of [(A + E) + (B - A) - (B + F)] and for the caudal wall segment as the value of [(C + G) + (D - C) - (D + H)] (Figure 1).

Results

The gilts showed no signs of distress or discomfort when restrained without sedation in the hydraulic chute on Days 5, 19, and 55.

Combined results for growth versus wear of both the cranial and caudal segments of the wall for the three pigs are shown in Tables 1 and 2. Mean growth rate exceeded the rate of wear (Table 1). Claw horn growth and wear rates were greater for rear feet and for the caudal wall. Mean growth rates for the inner claws (front and rear) and outer claws were 6.7 and 5.8 mm per month, respectively. Combined growth and wear rates for the first 5 days were higher than for Days 0 to 19 and Days 0 to 55 (Table 1).

Toe length and claw size are shown in Table 3. The average toe length for the three gilts at the start of the trial was 33.0 mm. Average toe lengths for front and rear feet for the three gilts were 32.6 and 33.4 mm, respectively, at the start of the study, and 35.7 and 37.3 mm, respectively, after 55 days. Toe length increased for all claws except the left front inner claw, in which the toe length decreased (Table 3).

Average claw size for the three gilts was 1046 mm² at the beginning of the study and 1277 mm² after 55 days. Claw size for front feet increased from 1282 mm² to 1366 mm² (an increase of 84 mm²), whereas size for rear

Figure 1: Tattoo line along the coronary band just above the skin and horn junction of a gilt's foot, and horizontal and vertical lines in the abaxial wall made using a power file. (Cr) represents the cranial wall segment and (Cu) the caudal wall segment. The extent of growth was calculated from the value of (B - A) for the cranial wall and (D - C) for the caudal wall. Wear for the cranial wall was calculated as the value of [(A + E) + (B - A) - (B + F)] and for the caudal wall [(C + G) + (D - C) - (D + H)]. Illustration by D. K. Haines © 2010 The University of Tennessee. Illustration reproduced with permission of The University of Tennessee.

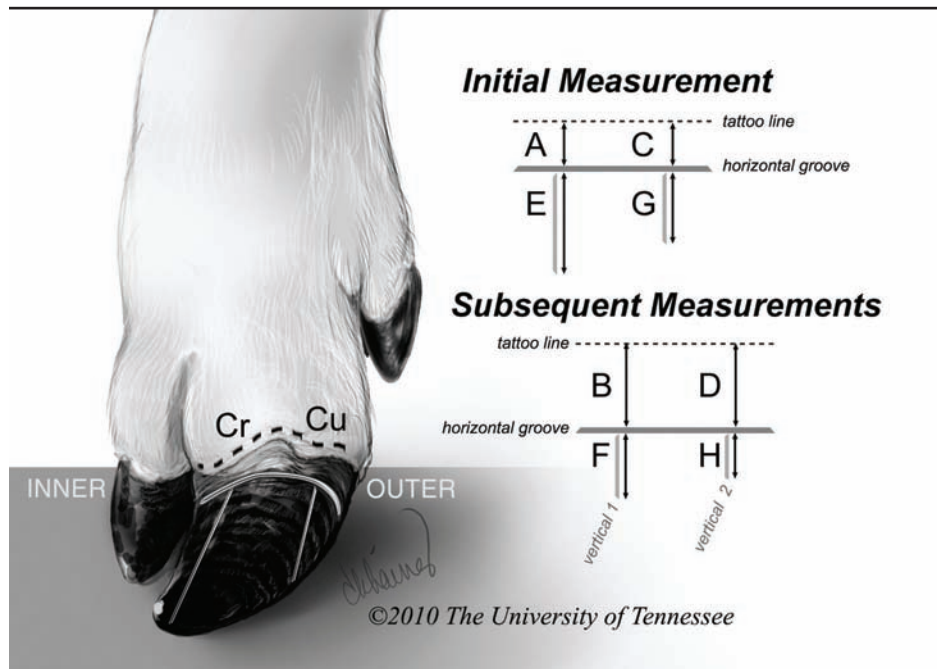


Figure 2: Measurements in gilts for toe length (1) along the dorsal wall from just below the coronary band to the end of the wall, and claw diagonal (2) along the abaxial wall from the bottom of the wall at the toe to the top of the abaxial groove (wall-heel junction). Illustration by D. K. Haines © 2010 The University of Tennessee. Illustration reproduced with permission of The University of Tennessee.

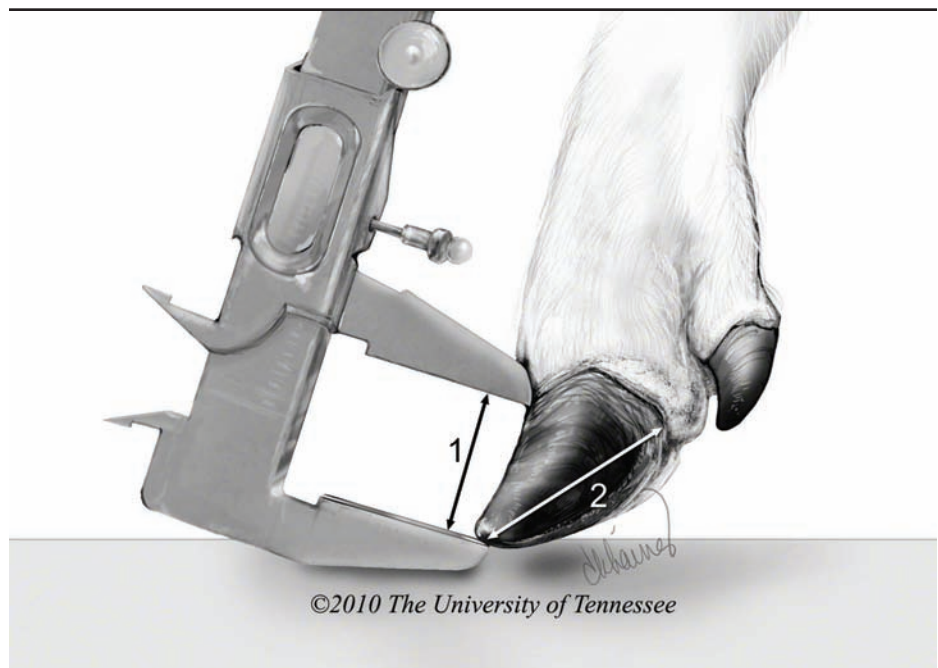
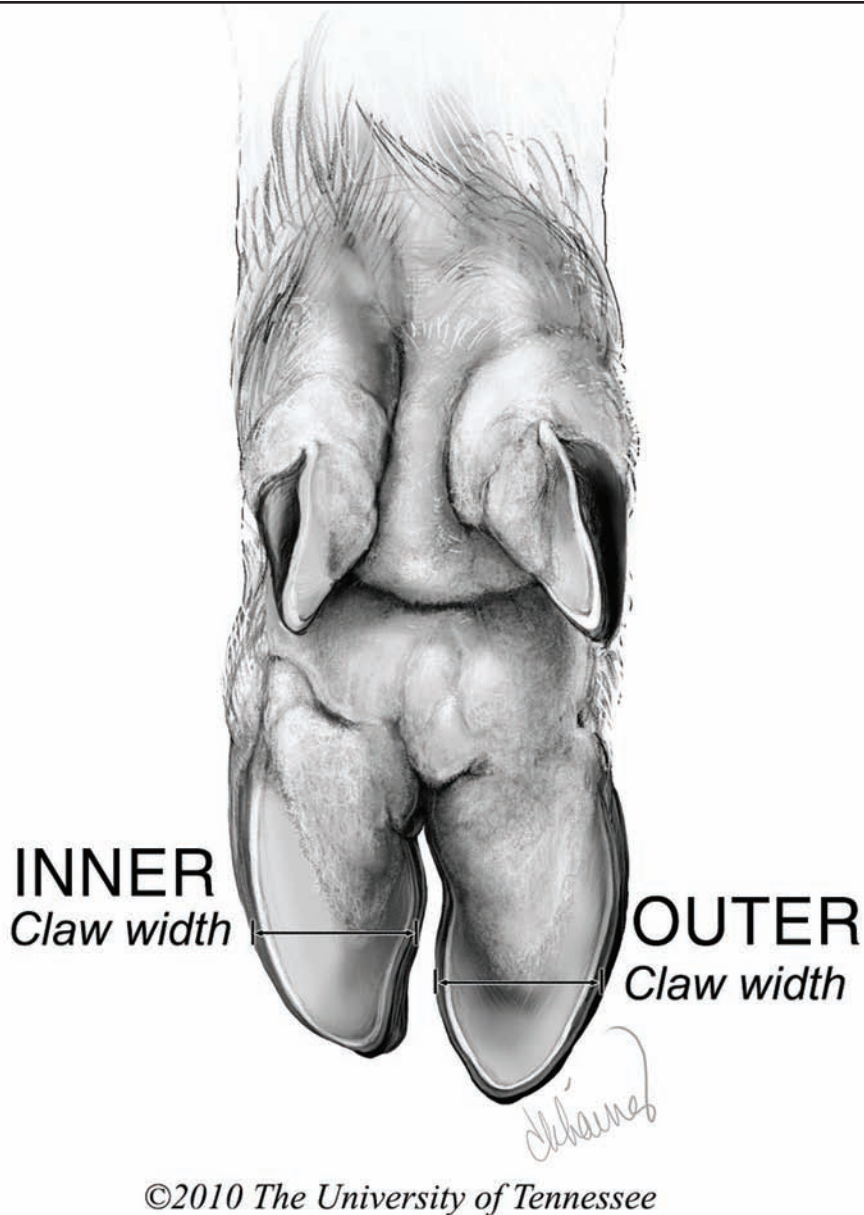


Figure 3: Measurement in a commercial gilt of claw width across the sole at the heel-sole junction, used for calculation of claw size in mm² (claw size = claw diagonal × claw width). Illustration by D.K. Haines © 2010 The University of Tennessee. Illustration reproduced with permission of The University of Tennessee.



feet increased from 1076 to 1112 mm² (an increase of 36 mm²). Overall, mean claw size for both rear inner claws (859 mm²) was smaller than that for the rest of the claws (1238 mm²) (Table 3).

Claw horn lesions were present in all three gilts at the start of the study. In two gilts, there was separation of the abaxial white line in the left rear outer claw, classified as lesion score 1 and defined as shallow separation, short separation, or both. In addition, in one of these gilts, there was

heel erosion of the left rear outer claw (lesion score 1, defined as mild overgrowth, erosion, or both) and wall hemorrhage (focal area of red discoloration beneath unpigmented part of the abaxial wall) of the right rear inner claw. In the third gilt, there was a heel-wall crack (lesion score 1, defined as short shallow crack at the wall-heel junction) on each outer claw of the rear feet, a heel-sole crack (lesion score 1, defined as slight separation at the heel-sole junction) on the left rear outer claw, heel

erosion (lesion score 1) on the right front inner claw, and a heel-wall crack (lesion score 1) on the left front outer claw. The lesions were still present at the end of the study, again classified as score 1.

Discussion

The mean claw horn growth rate of 11.6 mm per 55 days (6.3 mm per 30 days) found in this study is less than that reported in another study,⁴ where growth rates of 10 and 11 mm per 28 days were found. However, the pigs in that study were younger and weighed 18 kg when the study began and 118 kg when it ended. The pigs in the present study weighed 113 kg when the study began and 150 kg when it ended. It is reported that horn growth diminishes with age.⁴

The overall mean wear rate for the 55 days of this study was 9.6 mm (5.1 mm per month), which is more than previously reported.⁴ The increase in toe length despite access to a concrete walking surface indicates that claw overgrowth may occur over time. The more rapid rate of caudal wall horn growth and wear may result in relative less mature (keratinized) horn being present in this area. Claw size expressed as a function of claw width times claw diagonal was very similar for the claws of the front feet, whereas there was a discrepancy in size between the inner and outer claws of the rear feet. Most claw lesions were present on the outer claw of the rear leg. Similar findings have been reported in another study.⁵

Further investigation regarding weight-bearing dynamics and claw horn growth and wear is needed, using a larger group of pigs, before more definitive conclusions can be made.

Implications

- Under the conditions of this study, a tattoo line created on the coronary band and grooved lines created on the claw wall using a power file remain clearly visible for at least 55 days.
- Mature crossbred commercial gilts remain calm when restrained in a hydraulic chute as described in this study.
- Under the conditions of this study, even when pigs have access to rough concrete flooring, horn growth may exceed the rate of wear.

Table 1: Separate and combined mean cranial and caudal wall horn growth and means and ranges for wear of the feet of three commercial crossbred gilts during a 55-day study*

Parameter	Mean (range)		
	Cranial wall segment	Caudal wall segment	Combined cranial/caudal
Days 0-5			
Growth/day (mm)	0.5 (0.3-0.8)	0.5 (0.3-0.9)	0.5 (0.3-0.9)
Wear/day (mm)	0.3 (0.0-1.0)	0.3 (0.0-0.5)	0.3 (0.0-0.8)
Days 0-19			
Growth/day (mm)	0.3 (0.1-0.4)	0.1 (0.1-0.3)	0.2 (0.1-0.4)
Wear/day (mm)	0.1 (0.0-0.2)	0.1 (0.1-0.2)	0.1 (0.0-0.2)
Days 0-55			
Growth/day (mm)	0.2 (0.1-0.3)	0.2 (0.1-0.3)	0.2 (0.1-0.3)
Wear/day (mm)	0.2 (0.1-0.3)	0.2 (0.1-0.2)	0.2 (0.1-0.3)
Growth/month (mm)	5.5	7.0	6.3
Wear/month (mm)	5.0	5.3	5.1
Growth + or - (mm)	+0.5	+1.7	+1.1

* Commercial crossbred gilts weighing 113–150 kg.

- The discrepancy in the size of the claws on the rear feet as well as the distribution of claw horn lesions indicate that the outer claw of the rear leg carries more weight relative to the inner claw and thus bears more of the mechanical insult related to locomotion.
- Under the conditions of this study, claw horn growth and wear rates are greater for rear feet, so that less mature keratinized horn cells may be exposed to the walking surface, predisposing to development of claw horn lesions.

Acknowledgement

The authors would like to thank Zinpro Performance Minerals, Eden Prairie, Minnesota, for supplying the experimental animals and Dr Taylor Boone for technical support.

Table 2: Growth and wear means (ranges) in mm of individual claws for the feet of three commercial crossbred gilts

Claw	Growth/day	Wear/day	Growth/month	Wear/month	Growth (+) plus wear (-)
Hind limb					
LO cranial	0.2 (0.1-0.3)	0.2 (0.2-0.3)	7.2 (4.0-9.0)	6.8 (5.8-7.6)	+0.4 (-1.8 to +1.5)
LO caudal	0.3 (0.2-0.3)	0.2 (0.2-0.3)	7.8 (4.9-9.9)	7.1 (5.4-8.4)	+0.7 (-0.5 to +1.5)
LI cranial	0.2 (0.2-0.3)	0.2 (0.2-0.2)	6.3 (5.1-7.9)	5.6 (4.6-6.4)	+0.2 (-0.7 to +1.5)
LI caudal	0.6 (0.2-0.3)	0.2 (0.1-0.3)	7.6 (6.9-8.1)	7.4 (5.1-10.0)	+0.3 (-1.9 to +1.8)
RO cranial	0.2 (0.2-0.3)	0.2 (0.2-0.2)	7.0 (5.1-8.4)	4.9 (4.4-5.9)	+2.1 (+0.6 to +4.0)
RO caudal	0.2 (0.2-0.3)	0.2 (0.2-0.2)	7.1 (5.6-8.1)	5.9 (4.6-6.8)	+1.3 (+0.8 to +1.9)
RI cranial	0.2 (0.2-0.3)	0.2 (0.2-0.2)	6.2 (5.1-8.1)	6.3 (5.8-6.6)	+0.1 (-0.7 to +1.6)
RI caudal	0.3 (0.2-0.3)	0.2 (0.2-0.2)	6.4 (4.7-9.5)	5.4 (4.9-5.8)	+1.0 (-0.2 to +3.1)
Front limb					
LO cranial	0.1 (0.1-0.2)	0.2 (0.1-0.2)	3.6 (3.6-3.8)	5.0 (3.8-5.1)	-0.6 (-0.2 to -1.3)
LO caudal	0.2 (0.1-0.2)	0.2 (0.2-0.2)	4.5 (4.0-5.1)	5.1 (4.6-5.7)	-0.9 (-0.3 to -1.2)
LI cranial	0.1 (0.1-0.2)	0.1 (0.1-0.2)	3.3 (1.7-5.3)	3.5 (3.2-3.8)	-0.2 (-1.5 to +1.8)
LI caudal	0.3 (0.2-0.7)	0.1 (0.1-0.2)	4.2 (2.1-5.4)	4.2 (3.7-4.8)	+0.0 (-0.3 to +1.7)
RO cranial	0.1 (0.1-0.2)	0.1 (0.1-0.1)	3.0 (1.9-4.4)	1.5 (0.2-2.5)	+1.7 (-0.7 to +4.2)
RO caudal	0.1 (0.1-0.2)	0.1 (0.0-0.1)	3.7 (2.6-4.6)	1.5 (0.8-1.8)	+2.2 (+1.9 to +3.9)
RI cranial	0.2 (0.1-0.2)	0.1 (0.1-0.2)	4.6 (3.4-6.3)	4.1 (4.0-4.3)	+1.3 (-0.3 to +2.3)
RI caudal	0.2 (0.1-0.3)	0.1 (0.1-0.2)	5.5 (4.1-7.9)	4.4 (3.1-5.5)	+1.1 (-0.5 to +4.8)

LO = left outer; LI = left inner; RO = right outer; RI = right inner.

Table 3: Toe length and claw size of individual claws for three commercial crossbred gilts during a 55-day study period

Claw	Toe length mean (range) (mm)		Δ (mm)*	Claw size mean (range) (mm ²)†	
	Day 0	Day 55	Days 0-55	Day 0	Day 55
Hind limb					
LO	34.8 (34.1-35.9)	39.3 (38.6-39.7)	+ 4.5	1084 (929-1269)	1278 (1255-1303)
LI	29.0 (20.09-35.3)	34.8 (31.2-37.6)	+5.8	761 (704-816)	952 (874-1058)
RO	35.6 (34.0-36.9)	39.2 (36.6-42.8)	+3.6	1034 (828-1296)	1254 (1225-1274)
RI	34.4 (33.3-35.1)	36.1 (33.1-37.6)	+1.7	756 (705-817)	967 (855-1034)
Front limb					
LO	31.9 (29.5-35.4)	35.0 (34.3-35.6)	+ 3.1	1174 (1056-1316)	1490 (1350-1700)
LI	32.8 (29.3-36.8)	29.8 (23.4-34.2)	-3.0	1181 (1127-1242)	1376 (1222-1456)
RO	34.1 (32.9-35.9)	36.6 (35.1-237.6)	+2.5	1227 (1058-1350)	1241 (1224-1275)
RI	31.4 (29.0-35.4)	34.9 (33.1-36.6)	+3.5	1158 (1058-1222)	1360 (1225-1479)

* Δ = change in toe length = (toe length Day 55) – (toe length Day 0).

† Claw size = (claw diagonal \times claw width).

LO = left outer; LI = left inner; RO = right outer; RI = right inner.

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