Changes in Feet and Leg Joint Angles in Gilts Divergently Selected for Residual Feed Intake during their First Gestation

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Summary and Implications

This study attempted to characterize any potential changes in feet and leg characteristics due to gestation stage, genetic line difference or lameness status during the gilt's first gestation. Joint angles for knee, hock, front and rear pastern were measured in 40 Yorkshire gilts divergently selected for residual feed intake (RFI) on days 30, 60 and 90 of gestation. On the same days, gilts were scored for walking lameness (i.e. lame or non-lame) Significant differences ($P < 0.05$) between gestation day and lameness status were identified in the knee and both pasterns. Significant differences ($P < 0.05$) in RFI line were also observed in both pasterns. These measurements suggest that as gestation progresses, structural changes occur. Similarly, differences between RFI lines may be due to some underlying genetic effect that has not previously been identified. In this study, lame sows were also observed to have greater joint angles for the knee, front and rear pasterns; however, such differences were minimal and their biological relevance is unclear.

Introduction

Individual conformation traits, such as pasterns, knees and hock position have been associated with sow longevity and survivability. Studies have suggested that feet and leg conformation could change as age progresses. To our knowledge, no studies have investigated these traits during a gestation period using objective feet and leg conformation measuring methods. Additionally, joints have been shown to change quickly to unfavorable angles under divergent selection experiments suggesting that genetic selection for production traits such as feed efficiency could have a detrimental effect on fitness traits. Therefore, it is important to identify how conformation changes when replacement gilts are divergently selected and as they age. The objective of this study was to evaluate changes in feet and leg joint angle measurements during one gestation within the entire 10th generation of gilts divergently selected for residual feed intake (RFI) at Iowa State University.

Materials and Methods

The protocol for this work was approved by the ISU-IACUC committee. This work was conducted between August 2015 and June 2016.

Animals: Forty Yorkshire gilts, representing the entire 10th generation of Iowa State University's Residual Feed Intake (RFI) lines (low RFI n=23 and high RFI n=17) were used.

Lameness Scoring: Gilts were scored for lameness when moving from her home stall to the testing pen using a 3-point scale (Table 1).

Video Equipment: Video was recorded in a gestation stall on days 30, 60 and 90 of gestation. A video camera (Go Pro Hero) was fixed to the opposing stall. The sow was filmed continuously (30 frames per second) until she laid down and stood up one time, or an elapsed time of 2.5 hours.

Video Analysis: Images were extracted from the videos to profile digital images using computer software (AVcutty v3.5, Andreas von Damaros, Krefeld, Germany, www.avcutty.de). Joint angles for the knee, front and rear pastern, and hock were measured using the angle feature in image analysis software ImageJ (ImageJ, National Institute of Health, Bethesda, MD) using a modified methodology by Stock et al. (2015) from the scoring method developed by The Norwegian Pig Breeders' Association (Norsvin, Hamar, Norway).

Knee angles were measured running on the front and back of the joint between the radius/ulna and carpals, with the contour sides of that joint acting as the anchor.

Front pastern angles were measured in reference to the floor, where the contour of the joint between the carpals and metacarpals is the reference point for the front pastern measurement that runs a line down the top and bottom of the hoof to a straight edge that traces a line back.

Hock angles were measured running on the front and back of the joint between the fibula/tibia and tarsals, with the contour sides of the joint acting as the anchor.

Rear pastern angles were measured in reference to the floor, where the contour of the joint between the tarsals and metatarsals is the reference point for the rear pastern measurement that runs a line down the top and bottom of the hoof to a straight edge that traces a line back.

Statistical Analysis: Mixed model equation methods were used to evaluate gestation day, RFI line and lameness score for the feet and leg joint angles evaluated. PROC MIXED of SAS (SAS Inst. Inc., Cary, NC) was used to analyze the data.

Results and Discussion

Gestation days: Differences between gestation days were observed in all angle measurements except for the hock ($P < 0.05$). Angles decreased 1.1 ± 0.5, 2.9 ± 0.9 and 3.0 ± 1.0 degrees between days 60 and 90 of gestation ($P < 0.05$) in the knee, front and rear pasterns, respectively and a similar tendency was observed between days 30 and 90 of gestation ($P < 0.10$) in those same joints.

RFI lines: Low RFI gilts had straighter front (60.9 vs. 57.9 ± 0.9 degrees) and rear (66.1 vs. 58.7 ± 1.1 degrees) pastern joint angles ($P < 0.05$). The hock was not associated with any of the predictor traits ($P > 0.10$).

Lameness score: (Table 1) Lame gilts had straighter knee (160.8 vs. 159.8 ± 0.4 degrees), front (60.1 vs. 58.6 ± 0.8 degrees) and rear (63.7 vs. 61.1 ± 1.0 degrees) pastern joint angles ($P < 0.05$).

The hock was not associated with any of the predictor traits ($P > 0.10$).

Under the conditions of this study differences in joint angles were observed as gestation progressed; however, such differences were minimal and their biological relevance is unclear. Nonetheless, results suggest that significant life events such as pregnancy play a role in changes in gilts' feet and leg structure. Although previous research suggests that pastern angles are lowly heritable, the differences observed between RFI lines may suggest that as the lines were divergently selected for RFI, there was also indirect selection for divergence in the rear pastern angle. Future research should follow first parity sows over several parities to identify joint angle differences over their production life and their possible effect on longevity.

Table 1. Walking lameness scoring system

Score	Description	Definition
1	Normal	Sow moves with unaltered gait on all limbs
2	Moderately lame	General stiffness, altered gait on affected limb(s)
3	Severely lame	Non-weight bearing on affected limb

Table adapted from Calderon Diaz et. al 2015

Table 2. Differences (LS means ± SE) in knee, front and rear pastern and hock joint angles between lame and non-lame gilts from the 10th generation of females divergently selected for Residual Feed Intake (RFI) at days 30, 60 and 90 of gestation.

Variable	Knee		Front Pastern		Rear Pastern		Hock	
	LS Means	SE	LS Means	SE	LS Means	SE	LS Means	SE
Gestation Day[1]								
30	160.5[a,b]	0.5	59.7[a,b]	0.9	62.7[a,b]	1.1	154.7[a]	0.6
60	160.8[a]	0.5	60.6[a]	0.9	63.8[a]	1.0	155.1[a]	0.5
90	159.7[b]	0.5	57.8[b]	0.9	60.8[b]	1.0	154.2[a]	0.5
RFI Line[2]								
Low	160.2[a]	0.5	60.9[a]	0.8	66.1[a]	1.1	155.2[a]	0.5
High	160.5[a]	0.6	57.9[b]	0.9	58.7[b]	1.2	154.1[a]	0.6
Lameness[3]								
Non-lame	159.8[a]	0.4	58.6[a]	0.7	61.1[a]	0.9	154.8[a]	0.5
Lame	160.8[b]	0.5	60.1[a]	0.9	63.7[b]	1.1	154.5[a]	0.6

[1] Observations were made at 30, 60 and 90 days of gestation
[2] Lines were from the 10th generation of the residual feed intake lines from Iowa State University
[3] Lameness defined as non-lame and (mildly) lame; no animals were severely lame
[a,b] Within columns, significant differences between predictor variables; $P < 0.05$