Claw lesions in lactating sows on commercial farms were associated with postural behavior but not with suboptimal reproductive performance or culling risk

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Claw lesions in lactating sows on 3 commercial farms were assessed in 6 areas of each of a sow’s 8 claws to investigate the relationship between claw lesions and stage of lactation. In addition, the relationships between claw lesions and postural behavior, reproductive performance or culling risk were investigated. We used a 5-point score method (0, 1, 2, 3 or 4) for each claw area and overgrown heel was additionally scored. Total sow-lesion score (TSLS) for each sow was obtained by summing the scores for the 6 areas of the 8 claws. The highest claw lesion score for each sow was defined as the highest claw lesion score (HCLS) recorded in the 48 claw areas. We recorded the relative frequency (%) of postural behavior by point sampling at 15-min intervals over a 6 h period. Linear mixed-effects models were used for statistical analyses. Of the 308 sows observed, mean TSLS was 17.3±0.40. Proportions of sows with HCLS 0, 1, 2, 3 and 4 were 0.0, 43.5, 50.6, 4.9 and 1.0%, respectively. The heel area had the highest proportions of claw-lesion score 2 or higher between the 6 areas (P < 0.05). There were more claw-lesion scores of 2, 3, and 4 in the hind limbs of lateral claws than in the front limbs (P < 0.05). High TSLS or HCLS was not related to the stage of lactation and no differences were found between HCLS groups or TSLS groups for overall culling risk after weaning (P > 0.10). There were no differences between TSLS groups for adjusted 21-day litter weight, preweaning mortality or weaning-to-first-mating interval (P > 0.10). No differences were found between HCLS groups for the sow performance (P > 0.10), although sows in the high TSLS group had a higher farrowing percentage than those in the low TSLS group (P < 0.05). There were no differences between HCLS groups for postural behavior (P > 0.10), but sows in the high-TSLS group had the highest relative frequency of lying posture and the lowest frequency of standing posture (P < 0.05). In summary, claw lesions in lactating sows were not related to negative reproductive performance and culling risk, but there was a relationship with postural behavior.

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1. Introduction

Increased numbers of lame sows would raise concerns about animal well-being. Claw lesions have been suggested to be an underlying cause of lameness in swine (Dewey et al., 1993) and in dairy cattle (Murray et al., 1996). A recent study found that 96% of gestating sows on a research farm had at least one claw lesion (Anil et al., 2007), and studies of cows on commercial farms found that 72 to 80% of cows had one or more claw lesions (Manske et al., 2002; Somers et al., 2003).

Claw lesions in dairy cattle have been associated with suboptimal performance (Sogstad et al., 2006) and increased culling risk due to lameness (Booth et al., 2004). Also, stage of lactation in dairy cattle has been suggested as a risk factor associated with claw lesions (Vermunt and Greenough, 1994). The stage of lactation in sows could be a risk factor for claw...
lesions because an increase in the stage of lactation of sows was associated with a higher frequency of postural changes (Tanaka and Koketsu, 2007). However, no studies have been conducted on commercial pig farms to the relationships between claw lesions and postural behavior, subsequent reproductive performance or culling risk nor have any studies been conducted on lactating sows to investigate associations between the severity of claw lesions and stage of lactation.

A sow has 4 feet each consisting of 2 claws (lateral and medial claws), and each claw consists of 6 areas that have been classified as wall, heel (including overgrown heel), white line, junction between heel and sole (heel–sole junction), sole and toe (Anil et al., 2007). Risk factors for claw lesions have been investigated in dairy cattle using the highest lesions score (Somers et al., 2003) or total-animal claw score (Vokey et al., 2001), and such scoring systems should also be appropriate to assess the relationship between claw lesions and performance or behavior in sows.

The objective of the present study was to assess claw lesions in lactating sows on commercial farms and to investigate the relationships of the claw lesions with reproductive performance, culling risk and postural behavior. We also determined the relationships between the claw lesions and stage of lactation.

2. Materials and methods

2.1. Farms

The present study was conducted on 3 commercial farrow-to-finish farms in Eastern Japan that used a computerized recording system (PigCHAMP Inc., Ames, IA, U.S.A.) which recorded reproductive performance of sows. This off-site study was approved by the Institutional Animal Care and Use Committee (IACUC) of the School of Agriculture, Meiji University. Average female-pig inventories on Farms A, B and C were 544, 561 and 817 pigs, respectively. The female pigs were Landrace and F1 crossbreds of Landrace and Large White, and they were housed in similar facilities on the 3 farms. The 3 farms had similar farrowing crates for lactating sows and each farm had 2 or 4 farrowing barns. The sides of the farrowing barns were formed by thermostatically controlled curtains for natural ventilation. The farrowing units consisted of a farrowing pen with a crate that was located on a totally perforated floor made of woven wire or cast iron. The mean dimensions (±SEM) of the farrowing crates on the 3 farms were length = 236.6 ± 1.21 cm, width = 53.4 ± 1.25 cm and height = 104.2 ± 1.36 cm. The mean weaning ages on Farms A, B and C were 27.0 ± 0.37, 24.5 ± 0.14 and 23.4 ± 0.14 days, respectively. Pregnant sows were moved from gestation stalls to farrowing crates approximately 7 days prior to expected farrowing date. Pregnant sows were housed in stalls on partially slatted concrete floors on all 3 farms. All the barns and floor designs on the three farms were planned by a veterinary company (Global Pig Farms, Inc., Shibukawa, Japan).

2.2. Claw lesions

We visited the 3 farms within 1 month during the summer in 2007 to observe the claw lesions and postural behavior of lactating sows in the farrowing crates. The 6 areas of each sow’s 8 claws were individually examined and scored for lesions by trained observers when sows were lying in the farrowing crates. There were four observers in the present study. The observers were trained on the anatomy and pathology of claw lesions, and how to observe claw lesions by veterinarians at Chiba NOSAI Veterinary Clinics (Yamada, Chiba, Japan) before the study began. The observers also practiced to score claw lesions of the same sows in a preliminary study. Each of 48 areas was given a single claw-lesion score (CLS) based on a 5-point score method (0, 1, 2, 3 or 4) for claw lesions (Table 1; Anil et al., 2007). The highest CLS of 2, 3 or 4 were considered as major lesions.

The claw lesions included erosion, cracks and overgrowths (Anil et al., 2007). The 6 areas within each claw (Fig. 1) were classified as wall, heel (including overgrown heel), white line, junction between heel and sole, sole and toe (Anil et al., 2007). The overgrown heel was defined as excessive growth of the heel tissue (Gjein and Larssen, 1995). Overgrown heel was additionally scored (Anil et al., 2007). Not many multiple lesions in an area were found. Only the most severe lesion was scored when more than one lesion was found in an area. The length or size of a lesion was not measured because often the several lesions were linked together, thus making it difficult to distinguish between independent lesions.

To evaluate the scoring system, 2 observers scored the same 3 sows on 1 farm, and kappa statistics were used to evaluate the inter-observer agreement; the inter-observer kappa value was 0.69. Due to the need to wait for the sows to be in the lying posture, time constraints prevented more than 3 sows being studied. However, this still enabled inter-observer comparisons of 144 claw areas and this allowed us to make a detailed comparison and evaluation of the scoring system for individual lesions.

2.3. Categories of claw lesions

The highest CLS for each sow was defined as the highest CLS (HCLS) recorded in the 48 claw areas (including overgrown heels; Somers et al., 2003). Sows were categorized into 3 groups based on the HCLS, namely HCLS 1, 2, and 3 and 4.

![Fig. 1. Illustration of the 6 areas of a claw: A = wall; B = heel, including overgrown heel; C = junction between heel and sole; D = sole; E = white line; F = toe.](image-url)
A total sow-lesion score (TSLS) was obtained by summing the CLS in the 48 claw areas (including overgrown heels), to give an indication of the overall severity of lesions in a sow. This method was based on a method developed previously in a dairy cattle study where scores of all hind claws were added for a total-animal claw score (Vokey et al., 2001). Sows were classified into 3 groups based on the upper and lower 25 percentiles of the TSLS: low (0 to 12), intermediate (13 to 23) and high TSLS (24 or higher).

2.4. Point sampling of postural behavior

We were only able to observe postural behavior in sows on Farms B and C, because we were not allowed to enter into the barns of Farm A in the morning. The behavior observers performed 6-h point sampling (Martin and Bateson, 1993) when the claw observers were assessing claw lesions. In the point sampling, the observers walked quietly along the rows of crated sows and observed the postural behavior at 15-min intervals for 6 h starting from the end of the morning-feed distribution (scheduled between 0730 and 0800). Relative frequencies of the postural behavior during the 6 h were expressed as a percentage of the total of 25 time observations. Three types of postural behavior were observed based on the following standard definitions: standing was a posture in which a sow was upright with all 4 feet on the ground; sitting was a posture in which a sow had her rear end on the floor with her 2 front feet on the ground; and lying was a posture in which a sow was neither standing nor sitting (Sekiguchi and Koketsu, 2004).

2.5. Definitions of reproductive performance

Sow performance data, recorded using PigCHAMP, were collected 6 months after the claw lesion observations. The data collected referred to the parity in which we conducted the claw lesion observations. The following sow performance data were collected: adjusted 21-day litter weight, preweaning mortality, weaning-to-first-mating interval, farrowing percentage and overall culling risk at 1, 3 and 5 months after weaning. Litter weight and preweaning mortality were measured at weaning. The adjusted 21-day litter weight was defined as the weaning litter weight for a sow which was adjusted to 21 days of age, 3 to 6 parities and 10 piglets per litter (NSIF, 1987; PigCHAMP, 1996). Farrowing percentage was defined as the number of farrowed females divided by the number of serviced females (Dial et al., 1992). Overall culling risk (percent) was defined as the number of sows culled during the 1, 3 and 5 month periods after weaning, divided by the number of sows scored for claw lesions × 100. The stage of lactation was the number of days a sow had been lactating when we observed its claw lesions.

2.6. Statistical analysis

All statistical analyses were carried out using SAS software (SAS Inst. Inc., Cary, NC). Binominal data were analyzed with mixed-effects logistic models using the GLIMMIX procedure with contrasts. Continuous data were analyzed with linear mixed-effects models using the MIXED procedure. Root transformation was carried out on the TLS. Additionally, arcsine transformations were also carried out on the proportions of the 3 types of postural behavior. Both means of the transformed data and SEM were back-transformed for presentation as results.

Model 1 was constructed for sows having CLS 1 or higher, and Model 2 was built for sows with CLS 2 or higher. The CLS in the Models 1 and 2 was categorized to perform logistic regression analysis on the data. Each model compared the proportion (%) of sows having the respective CLS between claw areas, between front limb (FL) and hind limb (HL) claws, and between lateral and medial claws. The independent variable was claw areas, FL and HL claws or lateral and medial claws. Comparisons of CLS between the claw areas were separately performed for each of the 8 claws. Model 3 was constructed to examine the relationship between stage of lactation and TSLS. The dependent variable was TSLS as a continuous variable. Additionally, Model 4 was built to examine the relationship between stage of lactation and the proportion (%) of sows having HCLS 2 or higher. The dependent variable in Model 4 was a binary variable as whether or not a sow had HCLS 2 or higher. There were no sows with HCLS 0. The independent variable was stage of lactation. Model 5 was constructed to compare differences in reproductive performance, culling risk and postural behavior between the HCLS groups or between the TSLS groups.

Parity and breed (F1 crossbreds or Landrace) were included in all the models. Stage of lactation was also included as a continuous variable in Models 1, 2, 3 and 4, and in the analysis of postural behavior in Model 5. The barns within the farm were included as random effects in all models to account for farm and barn variations. Additionally, the observers were included as a random effect in Models 1, 2, 3 and 4.

3. Results

The numbers of sows observed on Farms A, B and C were 92, 85 and 131 sows, respectively. The means (±SEM) of parity, stage of lactation and weaning age were 3.0±0.12, 12.1±0.43 days and 24.8±0.16 days, respectively. Of the 308 sows observed, mean TSLS was 17.3±0.40 and the proportions of sows with HCLS 0, 1, 2, 3 and 4 were 0.0, 43.5, 50.6, 4.9 and 1.0%, respectively. Table 2 shows the proportions (%) of sows with CLS 1 or higher, or CLS 2 or higher for different claw areas of each claw in the 308 sows. The heel area had the highest proportions of sows having CLS 2 or higher (P<0.05). The junction between heel and sole was the area with the highest proportion of sows having CLS 1 or higher, except for the HL left lateral claw (P<0.05).

More sows had heel area CLS 2 or higher in lateral claws in HL than in FL, but the opposite relationship was observed in medial claws (Table 3; P<0.05). With regard to the heel–sole junction area, more sows had CLS 2 or higher in HL than in FL (P<0.05), except for the left medial claws. In the HL heel and heel–sole junction areas, more sows had CLS 2 or higher in lateral claws than in medial claws (P<0.05). However, no such differences between lateral and medial claws were found in FL (P>0.10). There were no relationships between the stage of lactation and either proportions of HCLS 2 or higher, or TSLS (P>0.10).

Of the 308 sows, 56 were culled within 1 mo after weaning, but only 1 was culled due to lameness. No differences were
found between HCLS groups or TSLS groups for overall culling risk after weaning (P > 0.10; Table 4). Also, there were no differences between TSLS groups for adjusted 21-day litter weight, preweaning mortality, or weaning-to-first-mating interval, or between HCLS groups for sow performance (P > 0.10). However, 20.6% more sows were farrowed in the high TSLS group than in the low TSLS group (P < 0.05).

With regard to postural behavior, sows spent 70% or higher of the time lying, but there was no relationship between the proportions of sows lying, standing or sitting and HCLS groups (P > 0.10). However, when sows were categorized according to TSLS, the relative frequency (%) of lying posture was higher in the high TSLS groups than in the other groups (P < 0.05). Conversely, the proportion of standing sows was lowest in the high TSLS groups (P < 0.05). There was no difference between the TSLS groups in the relative frequency of sitting posture (P > 0.10).

4. Discussion

All sows had at least one area with CLS 1 (i.e., superficial lesion) or higher and this is consistent with a previous study (Anil et al., 2007). Also, 56.5% of sows had CLS 2 or higher in at least one area in their 8 claws, which is within the 30 to 70% range of sows with major claw lesions (CLS 2 or higher in our study) reported in earlier study (Gjein and Larssen, 1995).

We did not find any negative associations between claw lesions and reproductive performance, possibly because of only 3 sows with severe claw lesions (i.e., score 4) in our study. The positive association between TSLS and farrowing percentage in our study may be an indication of some sows being active and having high farrowing percentage. Also, TSLS included many superficial lesions and there were no associations between HCLS and farrowing percentage or the other measures of reproductive performance.

### Table 2

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### Table 3

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Table 2

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| Proportions (%) of sows with CLS 1, 2, and 3 or CLS 2, 3 and 4 for adjusted 21-day litter weight, preweaning mortality, or weaning-to-first-mating interval, or between HCLS groups for sow performance (P > 0.10). However, 20.6% more sows were farrowed in the high TSLS group than in the low TSLS group (P < 0.05).

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Our study is the first to determine the associations between claw lesions and postural behavior or culling risk on commercial farms. The relationship between claw lesions and postural behavior may raise some concern about animal well-being on commercial farms. It is important that swine producers or veterinarians pay attention to sows with severe claw lesions and postural behavior. However, there was no relationship between claw lesions and culling risk in sows, and so the producers might not have been concerned about animal well-being due to severe claw lesions when we visited their farms.

A previous study showed that cattle claw lesions were related to the stage of lactation (Holzhauer et al., 2008), whereas in our study we found no association between the claw lesions and stage of lactation. Our study was only conducted during lactation after the sows had been moved to farrowing crates with perforated floors made of cast iron or woven wire. However, during the gestation stage, prior to our study, these same sows had been housed in stalls with slatted concrete floors. Slatted concrete floors in gestation are considered a major factor contributing to claw lesions (Kornegay et al., 1990). Therefore, it is possible that some of the sows in our study had developed lesions during the gestation period before we made any observations. This possibility indicates that a longitudinal study on the occurrence of claw lesions during gestation and lactation is probably needed to help draw further conclusions.

The greater occurrence of lesions on HL claws than on FL claws, and on lateral claws compared to medial claws can be explained by sow weight distribution (Kroneman et al., 1993) and claw size (Kornegay et al., 1990). Lateral claws bear more of a pig’s weight than medial claws (Penny et al., 1963). Additionally, claw lesions increase as the size difference between the lateral and medial claws becomes larger (Kornegay et al., 1990), and it is known that in swine there is a greater size difference between lateral and medial claws of HL than of FL (Penny et al., 1963).

The greater occurrence of heel lesions in the medial claws of FL than of HL can be explained by research in dairy cattle that has shown that maximum pressure in FL is more often exerted on medial claws than on lateral claws (Van der Tol et al., 2002). The high occurrence of claw lesions in the heel areas and junction between heel and sole areas of sows in our study is probably due to the fact that the heel area consists of soft tissue and bears most of a pig’s weight (Gjein and Larssen, 1995). This maximum weight is largely born by the heel, particularly in lateral claws (Webb, 1984).

Fewer overgrown heels and wall lesions were observed in our study than previous studies (Gjein and Larssen, 1995; Anil et al., 2007). For example, Gjein and Larssen (1995) found that 50 to 80% of sows had overgrown heels and 30 to 40% had wall lesions. This discrepancy between our results and those of some others may be explained by large differences in farm conditions between countries, including conditions that we did not measure in our study such as flooring, genetics, nutrition and environmental factors.

In summary, our study showed within-claw and between-claw variability in the occurrence of lesions in lactating sows. The occurrence of claw lesions was related to postural behavior, but the lesions were not related to negative reproductive performance or culling risk.

One of the limitations of this study is that we did not repeatedly measure the claw lesions on the same sows. Furthermore, this study was not a controlled experiment, but an observational study using commercial farms. Thus, our findings should be interpreted only as associations, not as indicators of biological causation.

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