Original article

Survival and Risk Factors Associated with Claw Lesions of Female Pigs in Farrowing Crates on a Large Commercial Farm

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Summary

The objectives of the present study were to compare the occurrence of claw lesions in late-gestating pigs and lactating sows on a commercial farm and to investigate the relationships between claw lesions and parity, age of gilts at first mating, and survival probability. A farrow-to-finish farm was visited six times from 2007 through 2008 to observe the claw lesions of late-gestating pigs and lactating sows fed in farrowing crates in lactation barns. We used a four-point score method (0, 1, 2, or 3) for each of the seven claw areas in each of the eight claws of a female pig. The total pig-lesion score (TPLS) for each female pig was obtained by summing the scores of all the areas and claws in a pig. Two TPLS groups were formed on the basis of the upper 10th percentile of the TPLS : low (0 to 5) or high (6 or higher). Linear mixed-effects models were performed for statistical analyses. A Cox proportional hazards model was used to obtain the survival probability. Of 629 female pigs studied in the farrowing crates, 64.4% had one or more claw lesions. Mean TPLS ($\pm$ SEM) of the female pigs was 2.6 ± 0.15 . Late-gestating pigs had higher TPLS than lactating sows (4.1 ± 0.42 vs. 2.1 ± 0.14 ; $P < 0.05$). Moreover, TPLS was higher in later parity in both the late-gestating pigs and lactating sows ($P < 0.05$). However, there were no associations between the age of gilts at first mating and TPLS in late-gestating pigs ($P = 0.08$) or lactating sows ($P > 0.10$). Additionally, no associations were found between survival probability and TPLS in either the late-gestating pigs or lactating sows ($P > 0.10$). To facilitate animal well-being, we recommend that swine producers frequently examine claws of females in farrowing crates to identify females with severe claw lesions.

Keywords : claw disorder, parity, pig, risk factor, survival analysis

Introduction

Claw lesions raise some concerns about animal well-being on commercial farms due to pain in female pigs. A high or mild occurrence of claw lesions in female pigs has been reported by several researchers^{1,8)}. Claw lesions in female pigs have been suggested to be related to lameness on commercial farms^{1,4)}, with one study showing that lame sows had 62% more likelihood of having claw lesions than non-lame sows¹⁾.

It is important to determine the factors associated with claw lesions to identify females with lesions. A quick decision for treatment, culling or euthanasia of females with lesions is critical for animal well-being on commercial farms. Prevalence of claw lesions has also shown a slight tendency to increase with number of parity⁵⁾. However, the relationship between claw lesions and parity has not been fully elucidated in late-gestating pigs and

lactating sows on commercial farms. Additionally, no studies have compared the occurrence of claw lesions between late-gestating pigs and lactating sows, nor has the association between claw lesions and age of gilts at first mating been determined, which is critical for sow performance in low parity¹⁰⁾. No studies have yet determined an association between claw lesions and survival probability using survival analysis.

The objective of the present study was to investigate the relationships between the occurrence of claw lesions in female pigs on a commercial farm and parity, age of gilts at first mating, and survival probability. We also compared the occurrence of claw lesions between late-gestating pigs and lactating sows.

Materials and methods

Farm

A study was conducted on a commercial farrow-to-finish farm in Eastern Japan that used a computerized recording system (PigCHAMP Inc., Ames, IA, U.S.A.). Average female-pig inventory of the farm was 568 pigs during the study period. The female pigs on the study farm were Landrace and F₁ crossbreds between Landrace and Large White. Home-grown gilts were se-

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lected on the farm for normal leg structures and sound gaits at various gilt growing stages. Pregnant pigs were housed in stalls on partially slatted concrete floors. Late-gestating pigs were moved from gestation barns to farrowing crates approximately seven days before due date to parturition. The farrowing unit consisted of a farrowing pen with a crate that was located on a totally slatted cast iron floor. The dimensions of the farrowing crates were either 235 cm × 51 cm × 103 cm (length × width × height) or 233 cm × 54 cm × 104 cm.

The length, width, and height of the gestation stalls ranged between 213.0 and 224.0 cm, between 62.5 and 63.5 cm, and between 105.5 and 111.2 cm, respectively. The floor gaps in gestation stalls were between 2.5 and 3.0 cm wide. The sides of gestation and farrowing barns were formed by thermostatically controlled curtains for natural ventilation.

Definition of claw lesions

We visited the farm six times from July 2007 through November 2008 to observe the claw lesions of 143 late-gestating pigs and 486 lactating sows in the farrowing crates. When the female pigs were lying in the farrowing crates, the seven areas of each female's claws were individually examined and scored for lesions by trained observers using a simplified four-point score method. Each of 56 areas was given one claw-lesion score of 0, 1, 2, or 3. The claw-lesion scores are : 0 = no lesions, or superficial cracks or lesions in the epidermis ; 1 = deep lesions in the epidermis ; 2 = deep lesions extending into the corium ; and 3 = serious and deep cracks extending into corium and subcutis. If there was more than one lesion in an area we recorded the score for the most severe lesion. We did not measure the length or size of a lesion, because the lesions were often linked with each other and we were not able to objectively distinguish between independent lesions when we found more than one lesion.

The definition of lesions included erosion, cracks, and overgrowths. All eight claws per female were scored for lesions with the simplified four-point score method ; two claws on each of the two front limbs and two hind limbs. The seven areas within each of the eight claws were classified as wall, heel (including overgrown heel), white line, junction between heel and sole (heel-sole junction), sole, and toe¹⁾. To evaluate our scoring system, two observers scored the same three sows, and kappa statistics were used to evaluate the inter-observer agreement; the inter-observer kappa value was 0.73.

Categories of claw lesions

Based on a method developed previously in a dairy cattle study¹²⁾, the total pig-lesion score (TPLS) was obtained by summing of the claw lesion score in the 56 measured claw areas, and represented the magnitude of the lesions in a female. Female pigs were classified into two groups based on the upper 10th percentile of the TSLS : low (0 to 5) or high TSLS (6 or higher).

The highest claw lesion score for each female was defined as the highest claw lesion score (HCLS) recorded in the 56 claw

areas¹¹⁾. Female pigs were categorized into three groups based on the HCLS 0, 1 or higher, or 2 or higher.

Definitions of reproductive performance

Records for reproductive performance were collected six months after our claw observations. Four parity groups were separately built : late-gestating pigs in parity 0, 1, 2, and 3 or higher and lactating sows in parity 1, 2, 3, and 4 or higher.

Statistical analysis

All statistical analyses were carried out using SAS software (SAS Inst., Inc., Cary, NC). Binominal data, such as whether or not a female had HCLS, 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 with Tukey-Kramer multiple comparisons. Root transformation was carried out on the TPLS, and both the date and SE were back-transformed for the result presentation.

Model 1 was constructed to compare TPLS and whether or not a female had HCLS of 1 or higher or HCLS 2 or higher between the late-gestating pigs and lactating sows. Model 2 was built to examine factors for TPLS and whether or not a female had HCLS. The independent variables were age of gilts at first mating and parity. When the age at first mating was examined, the data were used for late-gestating pigs at parity 0 and 1 or lactating sows at parity 1 and 2. Separate analyses were performed for late-gestating pigs and lactating sows in Model 2. In Models 1 and 2, the observer ID and visit number, based on the date we visited (i.e. 1 to 6) were included as random effects. Of the 486 lactating sows, 64 were observed more than once. Female ID was also included as a random effect in Model 1 and Model 2 for lactating sows.

A Cox proportional hazards model with PHREG procedure was used to obtain the hazards for culling after farrowing (late-gestating pigs) or weaning (lactating sows). Of 630 claw observations, the first observations for 563 female pigs were used for survival analysis. Survival analysis was separately performed for 141 late-gestating pigs and 422 lactating sows. Surviving female pigs, dead female pigs, and female pigs culled due to old age were treated as censored subjects. The independent variable was either TPLS groups or HCLS groups. The parity and the visit number were included in the model using dummy variables to adjust for variations in parity and visit time effects.

Results

Mean parity numbers ($\pm$ SEM) observed in late-gestating pigs and lactating sows were 2.0 ± 0.15 and 2.8 ± 0.08 , respectively. Mean TPLS of the 629 female records was 2.6 ± 0.15 . The proportions of female pigs having HCLS 1 or higher, HCLS 2 or higher, and HCLS 3 were 64.4, 7.2, and 0.3%, respectively. Table 1 shows the comparison between the late-gestating pigs and lactating sows for the TPLS and for the proportions of female pigs having HCLS. The TPLS of late-gestating pigs was nearly

double that of lactating sows ($P<0.05$). The late-gestating pigs also had a 7.9% higher proportion of female pigs having the HCLS 2 or higher than lactating sows ($P<0.05$). No difference was found between the late-gestating pigs and lactating sows for the proportions of female pigs having HCLS 1 or higher ($P>0.10$).

Table 2 shows the comparison between the parity groups for the TPLS and for the proportions of female pigs having HCLS. Late-gestating pigs in parity 3 or higher had higher TPLS than those in parity 0 or 1 ($P<0.05$). In addition, late-gestating pigs in parity 3 or higher had the highest proportion of female pigs having the HCLS 1 or higher between the parity groups ($P<0.05$). However, no difference between the parity groups was found for the proportion of female pigs having the HCLS 2 or higher in late-gestating pigs ($P>0.10$). Lactating sows in the parity 4 or

higher had a higher TPLS than those in parity 1 ($P<0.05$), but no difference was found between the parity groups for the proportion of lactating sows having the HCLS 1 or higher ($P>0.10$) or the HCLS 2 or higher ($P=0.07$).

The age of gilts at first mating was not associated with TPLS ($P=0.08$), the proportions of pigs HCLS 1 or higher ($P>0.10$), or the proportions of pigs having the HCLS 2 or higher in late-gestating pigs at parity 0 or 1 ($P>0.10$). Additionally, the age of gilts at first mating was not associated with TPLS, the proportions of HCLS 1 or higher, or the proportions of pigs having the HCLS 2 or higher in lactating sows at parity 1 or 2 ($P>0.10$).

Figure 1 shows the survival curves for 422 lactating sows between the TPLS groups. There were no associations between the survival probability and TPLS, the proportion of pigs having HCLS 1 or higher, or the proportion of pigs having HCLS 2 or

Table 1 A comparison between late-gestating pigs and lactating sows of the total pig-lesion score and of the proportions of pigs having the highest claw lesion score

Measurement	Late-gestating pigs	Lactating sows
n	143	486
Total pig-lesion score	4.1 ± 0.42^a	2.1 ± 0.14^b
Proportions of female pigs having the highest claw lesion score		
1 or higher	72.0 ± 3.77	62.1 ± 2.20
2 or higher	13.3 ± 2.83^a	5.3 ± 1.02^b
3*	1.4 ± 0.99	0.0 ± 0.00

^{a-b} Values (within a row) followed by different superscript letters differ ($P<0.05$).
* Proportions of pigs having the highest claw lesion score 3 were not analyzed because no lactating sows had any claw lesions with score 3.

Table 2 A comparison of total pig-lesion score or proportions of pigs having different highest claw lesion scores between parity groups of either 143 late-gestating pigs or 486 lactating sows

Parity	n	Total pig-lesion score	Proportions of pigs having the highest claw lesion score	
			1 or higher	2 or higher
Late-gestating pigs				
0	37	2.1 ± 0.46 ^b	56.8 ± 8.26 ^b	10.8 ± 5.18
1	29	3.3 ± 0.79 ^b	62.1 ± 9.17 ^b	10.3 ± 5.76
2	22	4.2 ± 0.93 ^{ab}	68.2 ± 10.16 ^b	9.1 ± 6.27
3 or higher	55	5.8 ± 0.84 ^a	89.1 ± 4.24 ^a	18.2 ± 5.25
Lactating sows				
1	154	1.4 ± 0.13 ^b	59.1 ± 3.97	3.9 ± 1.56
2	97	2.0 ± 0.38 ^{ab}	50.5 ± 5.10	4.1 ± 2.03
3	81	2.0 ± 0.33 ^{ab}	61.7 ± 5.43	1.2 ± 1.23
4 or higher	154	3.0 ± 0.29 ^a	72.1 ± 3.63	9.7 ± 2.40

^{a-b} Values (within a column) followed by different superscript letters differ ($P<0.05$).

Fig. 1 Survival curves for 422 lactating sows in either low or high total pig-lesion score groups (TPLS).

higher in the late-gestating pigs and lactating sows ($P > 0.10$).

Discussion

Our result showed that 64.4% of female pigs in farrowing crates had one or more claw lesions, and this is consistent with previous studies showing proportions of 86.4 and 96.2%^{1,8)}. These results confirm those of a previous study¹⁾ that suggest that claw lesions commonly occurs in female pigs during peripartum periods. However, the fact that 92.8% of female pigs had either no lesions or lesions only in the epidermis (i.e., HCLS 0 or 1) indicates that most of the claw lesions were mild regardless of parity groups. Additionally, our study showed no associations between claw lesions and age of gilts at first mating, which suggests that replacement gilts on our farm had been selected for desirable leg structures before their farm entry⁷⁾.

In our study, the greater occurrence of claw lesions in high- or mid-parity female pigs than low parity female pigs is consistent with previous study⁵⁾. As body weight of a female increases, the pressure exerted on each area of the claw and the resultant chance of injury to the female increases¹⁾. Therefore, the relationship between high parity and claw lesions can be explained by the increasing body weight of females that were fed on concrete floors⁵⁾. In our study, however, apparent claw lesions (i.e., HCLS 2 or higher) were not associated with parity in either late-gestating pigs or lactating sows. Therefore, in order to facilitate animal well-being it is necessary to identify females with apparent claw lesions in any parity. Additionally, claw lesions are easier to find in female pigs lying in farrowing crates than those in gestating stalls.

The present study is the first study to determine the association between survival probability and claw lesions in swine. In dairy cattle, cows with claw lesions have been associated with increased hazards of culling³⁾. However, our study showed no associations between survival probability and TPLS or HCLS, which suggests

that the presence or absence of claw lesions has no effect on the survival of female pigs on the study farm. Even so, female pigs having severe claw lesions should be removed from the farm to facilitate animal well-being.

In the present study, the increased number of claw lesions in late-gestating pigs compared to lactating sows suggests that the gestation period was a factor increasing the occurrence of claw lesions. Slatted concrete floors in gestation are considered to be a major factor contributing to claw lesions⁹⁾ and the female pigs on our farm were housed in the gestation stalls with partially slatted concrete floors. Slat design features, such as the space between slats, roughness of the surface, and edge designs are also crucial factors for injury²⁾. Furthermore, the pawing behavior of gestating pigs on the concrete floors, which is reportedly one form of the nesting behavior of late-gestating pigs⁶⁾, might also increase the occurrence of claw lesions, although we did not observe such nesting behavior in our study.

In conclusion, the present study indicated that over 60% of female pigs on the study farm had one or more claw lesions, but most of these lesions were mild. The occurrence of claw lesions was more prevalent in late-gestating pigs than in lactating sows. Severe claw lesions in animals are related to pain, and the pain of females increases concerns for animal well-being on commercial farms. Therefore, we recommend that swine producers frequently examine claw lesions of female pigs in farrowing crates.

This study was not a controlled experiment, but an observational study using a commercial farm. Thus, our findings should be interpreted only as associations, not as indicators of biological causation. Additionally, we did not observe the claw lesions in the gestating barns. Even with these limitations, our study provides valuable information for swine producers and veterinarians on the occurrence of claw lesions in late-gestating pigs and lactating sows fed on a commercial farm.

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原 著

大規模生産農場における分娩クレート飼育雌豚の蹄損傷と 生存時間, リスク因子との関連性

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要旨

本研究は、生産農場における妊娠後期の雌豚と授乳豚の蹄損傷の発生を比較すること、蹄損傷と産次、初交配日齢、及び生存時間との関連を分析することを目的とした。繁殖雌豚一貫経営農場に、2007年から2008年に6回訪問し、授乳豚舎で飼育されている妊娠後期の雌豚と授乳豚の蹄損傷を観察した。1雌豚当たり、8つの蹄において、それぞれ7部位に4段階の蹄損傷スコア(0, 1, 2, 3)を記録した。総蹄損傷スコア(TPLS)は、8つの蹄7部位における蹄損傷スコアの合計と定義した。雌豚はTPLSの上位10パーセンタイルによって、低TPLS(0から5)と高TPLS(6以上)に分類した。統計分析には、混合効果モデルと生存時間分析を用いた。分娩クレートで飼育されている雌豚629頭の内、64.4%は少なくとも1つ蹄損傷を持っ

ていた。平均TPLS(±SEM)は 2.6 ± 0.15 であった。妊娠後期の雌豚は授乳豚よりもTPLSが高かった(4.1 ± 0.42 vs. 2.1 ± 0.14 ; $P < 0.05$)。さらに妊娠後期の雌豚と授乳豚のいずれにおいても、TPLSは高い産次でより高くなった($P < 0.05$)。初交配日齢とTPLSは、妊娠後期の雌豚($P = 0.08$)と授乳豚($P > 0.10$)において関連がなかった。生存時間とTPLSは、妊娠後期豚と授乳豚において関連がなかった($P > 0.10$)。動物福祉向上の観点から、生産者は雌豚の重篤な蹄損傷を発見するために、分娩クレートで雌豚の蹄を頻繁に確認することが望ましいと考えられる。

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