Sow's *Streptococcus suis* Deafness and Piglets Crushing Rate

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Abstract
Infections caused by Streptococcus suis are considered a global issue in the swine industry since they are associated with septicemia, meningitis, endocarditis and arthritis. Moreover, it is a zoonosis that afflicts people in close contact with infected pigs or pork-derived products. In this research, we aim to study the presence of S. Suis, type 2, as a possible cause of deafness, in farrowing sows, in relation to piglets crushing which is a major pre weaning mortality problem. From the analysis of sow's reactions to specific sounds we studied if deafness influences piglets early crushing and by counting the number of piglets crushed and investigating the presence of S. suis infection we search for a correlation towards this problem.From the deafness test 78 sows (30%) were classified as non-reactive and sampled for bacteriology. These sows had a 0.65 avreage-crushed piglets per nest while reactive ones had 0.38 ($P<0.05$). There appears to be a cross correlation between infection of S. suis, hypacusia and neonatal crushing. Our results show how infections of the inner ear can be a problem for the productivity in intensive pig farms. It is interesting to underline the high number of deaf animals that crush on piglets (30%) confirming the importance of auditive recognition of nests. Prophylaxis with vaccines or antibiotic treatment against S. suis type 2 seem to be a valuable help in avoiding chronic forms of hypacusia and meningitis and pre-weaning mortality rate.

Keywords: hypacusia, S. suis, crushing

Introduction

Infections caused by Streptococcus suis are considered a global issue in the swine industry since they are associated with septicemia, meningitis, endocarditis and arthritis. Moreover, it is a zoonosis that afflicts people in close contact with infected pigs or pork-derived products. From the 35 capsular serotypes currently known, the 2 is considered as the most virulent and frequently isolated in both swine and humans causing causing severe disease outbreaks in swine herds (Wisselink et al., 2000). Different experimental models have been used to elucidate the infection but central parts of the pathogenesis still remain unclear (Gottschalk &Segura, 2000). In spontaneous infection, S. suis is generally believed to invade via the upper respiratory tract (Gottschalk & Segura, 2000) and in contrast to pigs with pulmonary lesions, S. suis was often the only bacterial pathogen isolated from pigs with neurologic lesions (Reams et al., 1994; Palmer, 1993). It is uncertain whether meningoencephalitis in pigs infected with S. suis results from nasal exposure (extension from the cribiform plate) or from septicemia (Clifton-Hadley et al., 1984) and here we aim to investigate whether the infection lead to a certain degree of hypacusia and may influence also pre weaning mortality rate by piglet crushing. This latter parameter describes the financial incoming of a pig farm; it is calculated on the number of weaned piglets per sow, per year and stands for productivity and ranges from 5 to 20%. It can increase with the elderly of sows, the numerousness of the nest, inadequate farming environmental conditions, ipofertility, embryonic death, dystocia, neonatal pathologies and piglets crushing (Edwards & Malkin, 1986; Fraser et al., 1990).

Crushing especially is a majour complicance accounting for up to 45% of all piglet deaths (Edwards, 2002). Litter and environmental factors (Weary et al., 1996a; Cronin et al., 1998; Weary et al., 1996b) can contribute to some extent to increase crushing but also the sow's maternal behaviour after farrowing has several implications. This attitude it is linked to sows' experience, hereditariness and hormonal factors. Sows are phylogenetically preset to not crush on piglets while laying down: they explore the ground with the muzzle and move piglets with legs or head but in intensive farm breeding systems the single crates and the pressed selection for productivity may have partly prevent this maternal attitude. Another important issue is the responsiveness of a sow to (the sound of) a piglet being crushed which takes into account sows' overall experience (Thodberg et al., 2002; Grandinson et al., 2003). It has been ascertained that a sow better reacts to piglet's screams more that to the tactile effect while a crushing is happening (Hutson et al., 1991) and this reaction is even higher during the first days after delivery when the crushing hazard is higher. Individual reactivity of sows to piglets shrills has been studied confirming that the more they' re reactive to those sounds the less crush on piglets. The focus of this research is to measure sows's crushing of newborns during their first days after nesting investigating whether deafness may influence a less reactivity to piglets screams stimuli. In particular we studied if Streptococco Suis, type 2 could be a cause of sensory hypacusia, involving the inner ear, so that this lack of hearing will increase the chance of crushing. Trough the analysis of sow's reactions to specific sounds we studied the role of deafness as a cause of early crushing, the correlation between deafness and presence of infection and number of died piglets by crushing per sow. To prove deafness also bacteriological analysis has been done. The importance of this work stands in amplify the knowledge concerning neonatal mortality causes helping the prevention of neonatal death which would result in improvement in piglet survival

Material and Methods

1. Deafness tests and crushing monitoring

Data were recorded in the farrowing compartment of a swine full cycle breeding farm.
The sows were lodged in horizontally ordered farrowing crates (2.74 X 1.75 m) according to the expected farrowing date. Underfloor heating and lamps for piglets and were provided .The piglet nest area was located laterally the sow. The sows were fed once a day untill farrowing and twice from the second postpartum day. During the whole study time, no medications were administered. To test deafness, 256 sows were checked in 3 different farrowing rooms in three different periods of the year (April, June and September 2006). The animals were 7 different commercial strains from Italian Landrace X Large White X Duroc boar. Triangle sensitivity tests were performed in moments of the days in which no food was distributed and no routine farm checks from farm personnel were done, avoiding extra disturbance noises. To evaluate animals' reactivity to acoustic stimuli, an operator used to play an acute sound from a musical triangle standing behind the animals in crates. At that moment, a second operator measured the triangle sound intensity by using a sound level meters (Assicontrol ASC-010). Sow behavior was observed and classified as: reaction standing up, reaction moving, reaction vocalizing, ignoring, no reaction. The first three classes where than more generally grouped as "positive reaction" while the last two as "negative reaction". All the data collected in this part of the research were put together in a table containing all information coming both from the single sows farming files and from the data collected during our tests: the farrowing room, sow code, number of the farrowing crate, dB level played near the animal during the triangle test, sow reactivity and number of crushed piglets (table 1). The number of crushed piglets in

all sows during the research were daily collected from farm personnel and noted in sows' personal files.

Table 1: Example of data collected from 12 sows during the study, full table available for the whole research consisted of data from 265 sows).

Sow Code	Nr crate	Reactivity (Y/N)	dB	Nr crushed piglets
4688	11	Y	89	
4411	9	Y	89	3
4109	7	Y	95	
4412	5	NO	95	2
3767	3	Y	91	
4402	1	Y	85	
4633	2	NO	89	2
4507	4	NO	93	2
4634	6	Y	92	1
4421	8	Y	94	
3725	10	NO	96	1
4530	12	Y	97	
…	…	…	…	…

2. Microbiologic test:

After triangle test and evaluation of sow's reactions a bacteriological analysis aimed to verify the presence of Streptococcus Suis type 2 in those animals classified as non reactive (table1). In vivo nasal swabs and post mortem isolation of the bacterial, from the inner ear were done. 78 Nasal swabs were collected in the sows three days after delivery to check the presence of the bacterial in the upper respiratory airways in this particular peripartum stressful moment. For microbial identification, a commercial kit based on agglutination methods was used. Following slaughter, 17 sows were necropsied and gross lesions were recorded. Tissues for microscopy, as well as swabs for microbiological culturing were collected from ears and tympanic bulla. From each animal, samples were taken from gross lesions as well as a standard of 8 tissues for histopathology and 8 tissues for microbiological culture, which was done aerobically at 37°C on 5% bovine blood agar.

Morphologically suspect colonies were subcultured and identified biochemically and serologically using standard methods. For histopathology, fixation in 4% neutral buffered formaldehyde, decalcification of relevant tissues, as well as processing of HE stained sections were performed and the presence of S. suis antigen was examined by immunohystochemistry using a previously published protocol from Madsen and collaborators (2001).

3. Statistic analysis

Variance analysis (Proc GLM, SAS, 2008) has been performed considering all those variables recorded during the research both from the single sows farming files and from the data collected during our tests. The model used is:

$$\mathbf{y_{ijk} = \mu + T_i + L_j + S_k + V_z + e_{ijkz}}$$

where:

y= number of crushed piglets or dead during lactation,

μ= general mean,

T_i = effect of i_{th} test effect (i = 1,..3),
L_j = genetic effect (j=1,…7),
S_k = animal effect (k = 1,..256),
V_z =number of delivery effect (z=1,…9),
e_{ijkl} specific random effect of each observation.

Results

From the deafness test and the data collected from single sows files we drawn information regarding the reactivity of the females to sound, the level of sound played and the number of piglets crushed after delivery. This is reported in table 1. The score of the sow's maximum response to the triangle sound appeared to be a crucial moment of observation because there were different behaviors from a simple movement of the ears looking for the sound, grunts, sitting up or standing up; sometimes they didn't just react to the stimulus. For this reason, we decided to group the reactions in two exclusive classes: reactive and non reactive (table 2) to sound.

Table 2: The data coming from the deafness test show the percentage of animals reacting or non-reacting to sound stimuli. During the three different days of tests, on average, the 30% of sows has been evaluated as hypoacusic since did not react to the stimuli.

Day	*N° sows tested*	*Positive reaction*	*Negative reaction*	*% positive*	*% negative*
29/04	88	69	19	78,4	21,6
13/06	84	59	25	70,2	29,7
27/09	84	50	34	59,5	40,5
Tot.	256	178	78	69,5	30,5

Seventy eight non reactive sows were found from the triangle test and they have been observed for the number of crushed piglets and microbiologic analysis.
The number of dead piglets observed during the trial was 119 of which 77 came from non-reactive sows and 42 to reactive ones.
These data were submitted to GLM procedure to evaluate deafness data (reactions and dB) together with productive parameters (weaned piglets per sow), a correlation between deafness and number of crushed piglets was found, on the other hand also the correlation between normal animals and number of dead by crushing is significant (table 3).

Table 3: Statistic analysis of the relation between deafness and piglet crushing

	Average crushed piglets per sow	**P**
Reactive	0.38 on litter	<.05
Non-Reactive	0.65 on litter	

The analysis showed that the animal and the genetic effects did not influence the number of crushed piglets; thus those parameters were dropped from the model. A productive parameter directly correlate with the increase of crushing is parity (P<0.01), as shown in table 4: at the

first delivery there were 0.8 crushed piglets/sow, a lower number of deaths was observed at second delivery while the phenomenon increases from the third delivery further on (table 4, figure 1).

Table 4: Relation between parity and number of crushed piglets (GLM)

Parity	Nr crushed piglets	SEM	P
1	0.8	0.21	<.001
2	0.6	0.21	<.05
3	1.33	0.23	<.0001
4	1.21	0.24	<.0001
5	1.35	0.27	<.0001
6	2.04	0.30	<.0001
7	1.6	0.4	<.0001
8	1.57	0.55	<.05
9	2.44	0.77	<.05

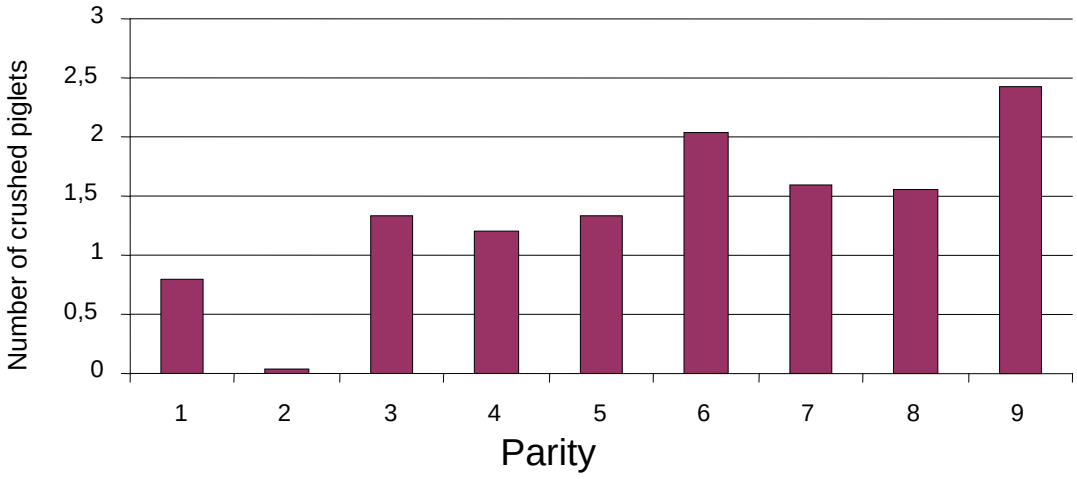

Figure 1: Parity and number of crushed piglets

The microbiologic results from the nasal swabs were negative to Streptococcus suis. This result anyway isn't indicative since sows in peripartum are treated with large spectrum antibiotics. On the other side the microbiologic analysis of the tympanic bulla from the head of slaughtered animals were positive to the bacterial. The animals tested for bacteriology showed 96% positivity against S.suis while the sows of the control group showed a lower percentage of 41%. Swabs from the inner ear have been done at slaughter day, the hystopathological analysis of the brain, middle and inner hear animals also showed microscopic lesions due to meningitis.

Conclusions

In this research it has been found that the 30 % of sows out of 256 animals observed were deaf and that there was a relation between deafness and crushing. Another important consideration raised is related to parity since the average of crushing resulted related to this parameter: high percentages of dead piglets by crushing has been observed, this is due to a partial development of the maternal attitude in young mothers (Lensink et al., 2008). At second delivery there is a halving of the percentage of crushing in comparison with the previous delivery. From the 3rd delivery, the reaction to piglet screams decrease and number of crushed piglets slightly increase probably because of bacteriological agents that develop chronic infections of the inner ear causing deafness or hypacusia. On the other side, younger animals may suffer less from deafness due to streptococci infections since they are less exposed to chronic infections and lesions. There appears to be a cross correlation between infection of Streptococcus suis, hypacusia and neonatal crushing. Our results evidence that a chronic infection of the inner ear can be a problem for productivity in a intensive pig farm, it is interesting to underline the high number of deaf animals which crush on piglets confirming the finding of Hutson, 1991, who stated that for sows physical contact is less important than auditive recognition of nests. Streptococcus suis type 2 diagnosis and antibiotic treatment against seem to be a valuable help in avoiding chronic forms of hypacusia and meningitis. This must be considered a form of prevention of newborn mortality and of zoonosis among workers in close contact with swine livestock. Improving Streptococcus diagnosis and therapy may reduce production costs that are also due to higher number of pre weaning mortality (64.7%).

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