**Improving survival, growth rate and animal welfare in piglets by avoiding teeth
shortening and tail docking?**

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ABSTRACT

Piglets are subjected to several painful procedures during their first week of life, including ear tagging, teeth clipping or grinding (although routinely prohibited in Europe), tail docking (although routinely prohibited in Europe), needle injections (vaccination and iron injection) and castration might be performed for male pigs. All these management practices cause pain and stress to the newborn piglets. The hypothesis of this experiment was that reducing painful interventions during the first week of life results in better zootechnical performance of the piglets, reduced piglet mortality and that the overall welfare is improved. To investigate this, the 4 lightest piglets of the experimental group (EE) were not subjected to tail docking and teeth clipping or grinding. The 4 lightest piglets of the control group (CL) and the other piglets of the experimental group (EC) and the control group (CC) received treatments as the common practice. There were differences in behavior, but there were no differences regarding weight at weaning between CL and EE. However, mortality rate was higher in the lightest piglets, that is, CL (34.1%) and EE (23.0%), whereas mortality rate in the other piglets was much lower (9.0% for CC and 9.3% for EC). This information can be useful for a veterinarian to advise farmers on whether painful interventions should be performed.

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INTRODUCTION

In the first week of life, several painful management practices are carried out on piglets (Vinuela-Fernandez et al., 2007): they get a numbered ear tag, teeth are shortened (although routinely prohibited in Europe), tails are docked (although routinely prohibited in Europe), they receive needle injections (vaccination and iron injection), and male piglets are castrated. Tooth shortening is not routinely allowed in Europe, but requires approval from a veterinarian. Nevertheless, it is still frequently applied to minimize wounds and lesions of the skin, in other piglets, and on the udder, in sows. Two techniques are used for tooth shortening: clipping or grinding. In the first days after tooth shortening, the intervention seems to have some advantages (fewer skin lesions on both the piglets' and the sows' udder) (Fraser 1975, Brookes and Lean 1993). In contrast, more recent work indicates growth advantages for piglets of which the canines were not shortened (Weary and Fraser 1999, Delbor et al., 2000, Bataille et al., 2002). Several authors (Gallois et al., 2005; Hay et al., 2004; Holyoake et al., 2004; Lewis et al., 2005; Meunier-Salaun et al., 2002; Noonan et al., 1994) state that shortening canines, whichever technique is used, leads to tooth lesions and pain.

Tail docking must also be approved by a veterinarian. Tails are docked directly or some days after birth (within the first 7 days), frequently without anesthesia or analgesia. Tails are snipped off with a heated knife so the wound is sealed at the same time. Sometimes, an ordinary cutter or bistoury knife is used, and antiseptic products might be applied on the wound. Tail docking is considered to be painful (Meunier-Salaun et al., 2002; Noonan et al., 1994; Simonsen et al., 1991), as the peripheral nerves in the tip of the tail are already fully developed in newborn piglets (Simonsen et al., 1991).

The hypothesis of our experiment is that reducing painful interventions during the first week of life results in better zootechnical performance of the piglets, reduced piglet mortality and that the overall welfare, as indicated by behavioral criteria, is improved.

The present study tries to bring new information into the debate on farm animal welfare

by focusing on the weakest piglets, which is a novel aspect compared with other reports. When a veterinarian advises pig farmers on applying painful interventions on piglets in order to prevent bigger problems, it is interesting to know whether piglet weight should be taken into account.

MATERIALS AND METHODS

Animals and Housing

Hybrid pigs (Piétrain x Hypor (Large White and Landrace cross pigs)) that were heterozygous for the halothane gene were used in the current study. All pigs were raised in the same housing conditions at the Zootechnical Centre (ZTC) – K.U.Leuven R&D (Belgium, Europe). All animals were individually marked with a numbered ear tag at day of birth and weaned in the fourth week after birth (mean $\pm$ SEM: 25.7 ± 0.106 days after birth). Piglets had *ad libitum* access to water and a commercial diet. Management was based on the “all in – all out” principle for each room.

A total of 295 piglets from 22 litters were observed from birth to weaning. Berndtson (1991) described a method for selecting or assessing the number of replicates for animal experiments. Based on his method and considering coefficient of variance and the difference to be detected, the sample size in the present experiment is sufficient to assess statistically significant differences with $p < 0.05$ and a power of 80 %. The number of female and male piglets within a litter was more or less equal, but the total number was not standardized. Cross-fostering was carried out in litters up to 7 days old to balance weight and number of piglets per litter. Six out of 22 sows were primiparous, but they were spread over treatment groups.

Experimental procedure

Piglets were handled according to the Belgian law on the protection of animals, and the experimental protocol was approved by the Ethical Committee on the use of experimental animals.

Litters were randomly divided into 2 main groups, a control group and an experimental group, and these main groups were each divided into 2 subgroups (Table 1). A few hours

after birth, all piglets were weighed individually to identify the lightest piglets within each litter. The number of gilts and boars within a litter was more or less equal, but the total number was not standardized.

Table 1 Experimental design

Experimental group		Control group	
EE (n = 44)	EC (n = 105)	CL (n = 44)	CC (n = 102)
4 lightest piglets of each pen	Other piglets in same pen as EE	4 lightest piglets of each pen	Other piglets in same pen as CL
Tails and teeth left intact; ear tagging, vaccination, iron and antibiotic injection and castration carried out as normal	All procedures (tail docking, teeth grinding, ear tagging, vaccination, iron and antibiotic injection and castration) carried out as normal	All procedures carried out as normal	All procedures carried out as normal

Piglets were weighed, had their teeth shortened and tails docked, and received a numbered ear tag and iron injection within the first day of life. Within the first week of life, they were vaccinated for *Mycoplasma hyopneumoniae* (Stellamune Mycoplasma, Intervet Nederland B.V., Boxmeer, The Netherlands), and received an injection of antibiotics (Duphamox LA, Fort Dodge Animal Health Benelux, Naarden, The Netherlands). These interventions were performed by the technicians under the supervision of the company veterinarian.

However, all piglet castrations were performed by the company veterinarian following the common castration technique, that is, with the piglet held in the hand of the technician (head down position). One transverse incision was made with a scalpel, and the testicles were removed by cutting the spermatic cord. Finally, a disinfectant (Cyclospray, Eurovet Animal Health, Heusen-Zolder, Belgium) was sprayed on to the wound and the piglets were returned to their pen.

If cross-fostering was necessary after the experimental procedure, this happened only between litters of the same treatment group. Body weight was measured every week until weaning.

Behavioral Observations

Behavioral observations were carried out the day of birth and the day after, and subsequently every week until weaning. The behavior of each litter of piglets was observed continuously for 10 minutes in accordance with a continuous focal sampling procedure (Fraser, 1978). The number of times a piglet performed a specific behavior during each minute was counted, making it possible to calculate the frequency of each behavior per piglet. This method of observing implies that a piglet could show a sequence of different behavioral events within a given single minute. The number of times each defined behavioral category was displayed per minute was taken into account when calculating the mean frequency of that behavioral category, that is, per minute for the total number of observed piglets. Behaviors were recorded as defined in the ethogram described by Hay et al. (2003). All behavioral categories were mutually exclusive. All observations, that is, 2 sessions of 10-minute duration per pen per day (AM and PM), were performed by a single observer standing in the central corridor of the pig house. Pens were observed at random during each session within a sequence according to a scan sampling procedure. The duration of each observation period (i.e., 10 minutes, multiplied by the number of pens) was considered adequate to achieve the objective of the present study. Twenty-two pens were included in the present study, which represented a total of 295 piglets. Each pen was observed for a period of 10 minutes, 2 times a day, giving a total of 440 min (7.33 hours) of continuous behavioral observations a day for the 22 pens. Hence, to make it feasible to combine observations that spanned over the entire weaning period and 295 animals, a sample frequency of 10 minutes per pen (2 times a day) was chosen. It was assumed that pen sampling matched time sampling, so that the observed behaviors per pen were a representative sample of the evolution of pain experienced by the animals over time.

The total observation time per pen, in combination with the number of pens (i.e., 22) was assumed to be sufficient to obtain an adequate understanding of the treatment effects studied (Hay et al., 2003; McGlone et al., 1993).

Statistical Analysis

All data were analyzed using SAS 9.2 (SAS Institute, Inc., Cary, NC, 2008) software. A significance level of 0.05 was used. Categories of behavior were grouped for analysis to have a sufficient number of observations within each grouped category, so that the empirical estimation could be carried out on a sufficient number of observations. A condition of the applied statistical model is that the performance of the empirical estimation passes the convergence test (Anonymous, 2006). Therefore, lateral lying, ventral lying, and sleeping were grouped under ‘lying’; suckling, udder massage and looking for teat were grouped under ‘udder activity’; huddled up, trembling, spasms, scratching, and tail wagging were grouped under ‘behavior indicative of discomfort’; nosing, chewing, licking, playing, and aggression were grouped under ‘interaction behavior’; walking and running were grouped under ‘walking’; and sitting, standing and kneeling were grouped under ‘postures’.

Behavioral data were not normally distributed; therefore data were dichotomized using the median as cut-off value. The binary data were analyzed using a logistic mixed model, with fixed effects for treatment and piglet weight, and with piglet as a random effect. The random effect accounts for the variability between the piglets within and between litters. The applied procedure (GLIMMIX, Anonymous, 2006) makes it possible to allocate a random effect to a variable (Anonymous, 2006), so that the piglets can be regarded as the experimental units. There are 2 factors to be considered in defining this random effect: the variability between litters and the variability between individual piglets. When taking into account the lowest level in the model, that is, the individual piglets, the variability between piglets partially represents the variability between litters. Values are presented as means $\pm$ SEM.

Data concerning body weight were analyzed using the generalized linear mixed model (MIXED) procedure (SAS, Institute, Inc., Cary, NC, 2008). Mortality rates were analyzed

using a logistic mixed model, with fixed effects for treatment and parity of the sow and with sow as a random effect.

RESULTS

Behavior from birth to weaning (4 weeks)

Piglets of the control group (CC) walked around more than the control piglets of the experimental group (EC) ($P < 0.0001$); the 4 lightest piglets of the control group (CL) walked around more than the 4 lightest piglets of the experimental group (EE) ($P = 0.0040$) and the EC ($P < 0.0001$) (Table 2).

Table 2 Walking (mean frequency per minute, minimum and maximum) observed during the entire nursery period

Treatment	Mean	Minimum	Maximum
CC	0.330 ^{a,b}	0	1.4
CL	0.329 ^b	0	1.2
EE	0.274 ^{a,c}	0	1.3
EC	0.264 ^c	0	1.2

Note: Significant differences at $P \leq 0.05$ are indicated by letters in the mean column.

^{a,b,c}Treatment groups without a common superscript differ. Means, minima and maxima are from the non-transformed data. Significant differences were obtained after analysis of the dichotomized data.

CC and CL showed more activity at the udder than EE ($P < 0.0001$ for CC and $P = 0.0021$ for CL) and EC ($P < 0.0001$ for CC and $P = 0.0009$ for CL) (Table 3).

Table 3 Udder activity (mean frequency per minute, minimum and maximum) observed during the entire nursery period

Treatment	Mean	Minimum	Maximum
CC	0.291 ^a	0	1
CL	0.282 ^a	0	0.9
EE	0.200 ^b	0	1
EC	0.200 ^b	0	1

Note: Significant differences at $P \leq 0.05$ are indicated by letters in the mean column.

^{a,b}Treatment groups without a common superscript differ. Means, minima and maxima are from the non-transformed data. Significant differences were obtained after analysis of the dichotomized data.

Growth rate

In the first week of life, CL grew the least ($P = 0.0142$ for CC; $P = 0.0243$ for EE, and $P = 0.0168$ for EC). In the second week, however, CC grew more than EC ($P = 0.0112$). In the third week, EE ($P = 0.0197$) and CL ($P = 0.0392$) gained less weight than EC. In the last week before weaning, EE put on less weight than piglets of the control group, both CC ($P = 0.0105$) and CL ($P = 0.0139$). Looking at the overall period from birth till weaning, EE gained less weight than CC ($P = 0.0005$) and EC ($P = 0.0064$) (Table 4).

206 **Table 4** Daily weight gain (g) during nursery period.

	Corrected Means (g)	Lower	Upper
Birth-week 1			
CC	0.286 ^a	0.238	0.333
CL	0.252 ^b	0.203	0.300
EE	0.288 ^a	0.236	0.339
EC	0.285 ^a	0.236	0.334
Week 1-week 2			
CC	0.392 ^a	0.334	0.451
CL	0.376 ^{a,b}	0.317	0.435
EE	0.369 ^{a,b}	0.306	0.432
EC	0.364 ^b	0.303	0.424
Week 2-week 3			
CC	0.389 ^{a,b}	0.318	0.459
CL	0.368 ^a	0.296	0.440
EE	0.365 ^a	0.288	0.441
EC	0.412 ^b	0.339	0.484
Week 3-weaning			
CC	0.187 ^a	0.122	0.251
CL	0.201 ^a	0.129	0.274
EE	0.132 ^b	0.0618	0.201
EC	0.164 ^{a,b}	0.0989	0.229
Birth-weaning			
CC	0.350 ^a	0.312	0.387
CL	0.340 ^{a,b}	0.300	0.379
EE	0.315 ^b	0.276	0.355
EC	0.342 ^a	0.304	0.380

207 Note: Means and confidence intervals are shown.

208 ^{a,b,c}Within a subcolumn, means without a common letter differ significantly at $P \leq 0.05$.

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Comparison of weight at weaning

The EE had a lower weaning weight than CC ($P = 0.0001$) and EC ($P = 0.0062$) (Table 5). There was no significant difference between EE and CL.

Table 5 Weight at weaning (kg) for the different treatment groups

CC	CL	EE	EC
8.65 ± 0.135^a	$8.21 \pm 0.265^{a,b}$	7.60 ± 0.230^b	8.30 ± 0.127^a

Note: Data are presented as lsmeans $\pm$ standard error.

^{a,b}Within a row, means without a common letter differ significantly at $P \leq 0.05$.

Mortality rate

Considering the 4 different treatment groups together, 14.9 % of all piglets died before weaning. In the CL group, 34.1 % died before weaning. In the EE group (tails and teeth left intact), 23 % died before weaning (Table 6). The most piglets died in group CL ($P = 0.0004$ vs. CC and $P = 0.0004$ vs. EC) and group EE ($P = 0.0184$ vs. CC and $P = 0.0098$ vs. EC).

Table 6 Mortality rate and moment of death for the different treatment groups

Treatment	Mortality rate	Time of death
CC	9.0% ^a	88.9% in week 1
	n = 9	11.1% in week 2
CL	34.1% ^b	93.3% in week 1
	n = 15	6.7% in week 2
EC	9.3% ^a	80.0% in week 1
	n = 9	20.0% in week 2
EE	23.0% ^b	80.0% in week 1
	n = 11	20.0% in week 2
All piglets	14.9%	86.4% in week 1
	n = 9	13.6% in week 2

Note: ^{a,b}Values without a common letter differ significantly at $P \leq 0.05$.

DISCUSSION

Behavior from birth to weaning (4 weeks)

Comparing the 2 groups of lightest piglets, the control group (CL) walked around more than the experimental group (EE). Molony and Kent (1997), Mellor et al. (2000) and Hay et al. (2003) observed increased restlessness in animals that were in pain. This behavior was interpreted as an adaptation to prevent littermates from inflicting more pain. The increased walking of the CL group may be interpreted in the same way.

CC and CL showed more activity at the udder than EE and EC. Although Hay et al. (2003) found that piglets are less active at the udder in the first 2.5 hours after castration (when they are in pain), Noonan et al. (1996) found that endorphins are released during suckling, hence creating an analgesic effect. Therefore, Noonan et al. (1996) related painful procedures to increased udder activity. Transposing that finding to the results of the present study, it is possible that the CL group experienced more discomfort than the EE group. This might be due to the extra procedures they were subjected to, tail docking and teeth clipping, as this was the only difference between both treatments. The differences between CC and EC point in the same direction, which can be explained by the synchronization of suckling behavior within each pen (Spinka et al., 2004).

The fact that CC walked more and were more active at the udder than EC could possibly indicate that CC were in more pain than EC. A possible explanation for this may be that EC were slightly heavier (on average: 1.60 kg) than CC (on average: 1.45 kg) and therefore might have experienced relatively less inconvenience from the treatments.

Growth rate

Until the last week before weaning, there was no difference in mean daily weight gain between the CL group and the EE group. In the fourth week, CL had a higher daily weight gain than EE. The explanation for this sudden change at the end of the nursery period could be that more piglets had died in the CL group in comparison with the EE

group (34.1% versus 23.0%). In the CL group, more of the lighter piglets had died, leaving behind the ‘stronger’, better growing piglets, whereas, in the EE group more lighter piglets survived, lowering the mean daily weight gain of the group. Overall, growth rate dropped during the fourth week, which might be explained by a decreased milk production of the sows (King et al., 1997; Whittemore and Kyriazakis, 2005). It is known that smaller pigs more often lose the fight for the highest milk-producing teat, so that they are more prone to a decreased growth rate in case of overall reduced milk production.

Comparison of weight at weaning

There is no significant difference between the EE group and the CL group. Nevertheless, it must be considered that a larger number of piglets was weaned in the EE group, which is a beneficial effect.

Survival rate

Survival is reduced in low-birth-weight piglets (Baxter et al., 2008). However, Knol et al. (2002) stated that genetic correlation between piglet survival until weaning and birth weight is low, indicating that selection on birth weight as an indirect way to improve pre-weaning survival is doubtful. Tuchscherer et al. (2000), in contrast, found that piglets that survived the nursing period were significantly heavier at birth than piglets that died before weaning. In the present study, this result was confirmed considering that more piglets died in the groups with the lightest piglets than in the other groups (34.1% of CL and 23.0% of EE vs. 9.0% of CC and 9.3% of EC). According to Tuchscherer et al. (2000), Herpin et al. (2002) and Baxter et al. (2008), the majority of preweaning deaths occurs within the first 72 hours postpartum. The results found in the present study agree with these authors, in that most of the deaths occurred within the first week of life. The rest of piglet deaths occurred during the second week; in the last 2 weeks of the nursing period no piglets died. The total percentage of piglets that died before weaning was 14.9, which is in agreement with Loncke et al. (2008), who stated that piglet mortality up to

15% is considered as acceptable in Belgium. These figures were obtained from a recent study in Belgium (Loncke et al., 2008) and are representative for Belgium. In the last decennia, the number of piglets per sow per year has increased drastically because of a thorough selection on fertility and productivity. With the selection for larger litters, preweaning mortality has increased, as the number of smaller piglets has increased too. On many pig farms, mortality during lactation exceeds 15% (Borges et al., 2005; Cutler et al., 2006). Although the aim is to decrease neonatal mortality significantly, the reality is that there is still a lot of work in this area for the pig sector.

CONCLUSION

The lightest piglets seemed to show less pain-related behavior when their teeth and tail were left intact. Moreover, mortality rate tended to be lower when compared with the lightest piglets of the control group. Hence, these results might be helpful for the company veterinarian to advise farmers on alternatives for application of painful interventions taking into account piglet's body weight. Further research, especially on neonatal mortality, would be useful.

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