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The Development of Pain in Young Pigs Associated with Castration and Attempts to Prevent Castration-Induced Behavioral Changes[1]

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ABSTRACT: Four experiments were conducted to examine the development of castration-induced behavioral changes, the effects of castration age on pig weight gain, and the efficacy of common analgesics for use in castrated pigs. In Exp. 1, behavioral changes associated with castration of pigs at 1, 5, 10, 15, or 20 d of age were evaluated. Castration caused measurable changes (reduced suckling, reduced standing, and increased lying times, $P < .05$) in the behavior of young pigs compared with that of intact pigs at all ages tested. Effects of age and interactions between age and castration treatment were not significant ($P > .10$) for any behaviors evaluated. In Exp. 2, the performance of pigs castrated at 1 d of age was compared with the performance of those castrated on d 14 and female littermates. Birth weights, weaning weights, and mortality were recorded. Pigs that were castrated on d 14 were heavier ($P = .05$) at weaning and had a higher ($P < .05$) weight gain during lactation compared to pigs castrated on d 1 of age. Pig mortality was similar among the treatments. In Exp. 3 and 4, the efficacies of pain-reducing drugs (nonnarcotic analgesics) were evaluated for effectiveness in reducing castration-induced behavioral changes in 8-wk-old pigs. Although castration reduced ($P < .05$) feeding time and weight gain, neither aspirin nor butorphanol influenced behavioral changes associated with castration. We conclude that pigs show similar behavioral changes (and probably pain perception) when castrated from 1 to 20 d of age. However, pig performance data favored castration at 14 d rather than at 1 d of age. Among older pigs, which show much greater behavioral effects of castration, analgesics (aspirin and butorphanol), used at recommended doses, provided no measurable effect on castration-induced behavioral changes.

Key Words: Pigs, Castration, Behavior, Pain

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Introduction

Virtually every U.S. establishment that produces pigs castrates young males to prevent poor meat quality and potential behavioral problems normally associated with the slaughter and housing of intact boars. The age at which a pork producer castrates male pigs has traditionally depended on the type of operation and available labor resources. Recent animal welfare concerns about the pain that animals experience (Rose and Adams, 1989) cause the pork industry, scientists, and philosophers to ask crucial questions about how and when pigs develop pain sensitivity and what might be done to alleviate any possible pain associated with routine practices.

Previous research reported that pigs castrated at 2 wk of age were behaviorally less affected by castration than were pigs castrated at 7 wk of age (McGlone and Hellman, 1988). Additionally, the use of a local anesthetic prevented pain-induced behavior changes in 2-wk-old pigs but was ineffective in 7-wk-old pigs.

The objectives of these studies were 1) to determine whether there was an age (1 to 20 d) at which the pain associated with castration was minimized, 2) to compare performance and survival rate of male pigs castrated on d 1 or 14 of age and that of female pigs, and 3) to evaluate the efficacies of analgesics (aspirin and butorphanol) in reducing behavioral changes associated with the castration of 8-wk-old pigs.

Materials and Methods

General. Pigs were derived from a four-way rotational cross using Duroc, Hampshire, Yorkshire, and Landrace breeds. The castration procedure used was performed as previously described by McGlone and Hellman (1988). Briefly, two incisions were made with a disinfected scalpel. Each testicle was removed by pulling (not cutting).

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In Exp. 1 and 2, the pigs were housed in farrowing crates with their sows. The farrowing facilities were totally enclosed and environmentally controlled. The farrowing houses were two separate rooms that accommodated 16 sows each. Farrowing crates measured 1.52 m × 2.13 m with a 56-cm^2 center area for each sow. A 250-W heat lamp was located in the middle of the creep area in each crate. The sows had ad libitum access to a 14% CP sorghum-soybean meal diet that met or exceeded NRC (1988) requirements.

Pigs were processed within 24 h of birth (d 1). Needle teeth were clipped, ears notched, navel cord dipped in iodine, tails docked (females only), 1 mL of iron dextran given i.m. in the neck, and birth weights were recorded. Pigs were provided a 20% CP sorghum-soybean meal diet as creep feed starting at 2 wk of age. Water was available at all times to the sow and litter with an automatic water bowl. Pigs were weaned at the end of a 28-d lactation period. In Exp. 3 and 4, the pigs were weaned at 4 wk of age and placed in a nursery pen as intact litters. The nursery rooms were environmentally controlled facilities. Nursery pens were 1.52 m × 1.71 m with woven wire flooring.

Experiment 1: Age Effects on Behavior. Ten litters were used to determine the development of pain sensitivity in young pigs. On 1, 5, 10, 15, and 20 d of age, one male pig was randomly chosen, castrated, and identified with a mark. A control pig was also randomly selected and identified at this time. In most cases, the control littermate was an intact male. However, in a few cases, there were not enough intact males to complete the final day of observation, so a female littermate served as the control pig. A total of 100 observations (2 treatments × 10 litters × 5 ages) were collected for castrated and control pigs.

The behaviors of the castrated and control pigs were observed and recorded by a trained observer for the six consecutive hours immediately after the castration procedure. Previous research (McGlone and Hellman, 1988) indicated that castration affects feeding and other behaviors for 6 to 8 h after castration. Thus, a 6-h period was chosen as an acceptable minimum amount for observation. Behaviors were identified as suckling, standing, standing under the heat lamp, lying, and lying under the heat lamp, as previously described by McGlone and Hellman (1988). A bout of suckling was recorded when ≥ 50% of the pigs in the litter were participating.

Experiment 2: Pig Weights. A total of 744 pigs were used to determine the effects of castration on d 1 vs 14 of age compared with untreated female pigs. Measures included pig weight gain and survival. Both intact males (n = 405) and females (n = 339) were evaluated. Males were randomly selected to be castrated at 1 or 14 d of age. Pigs were weaned at 28 d of age and BW were recorded. Average daily gain was calculated. Litters served as blocks and each treatment was represented in each litter.

Experiments 3 and 4: Analgesics. Aspirin and butorphanol (respectively) were evaluated for their efficacies in altering behavioral changes associated with castration of 8-wk-old pigs. Four intact males from 10 litters were used in each experiment. Two additional littermates also were placed in the pen but were not otherwise involved in the experiment.

The four males were randomly assigned to one of four factorially arranged treatments. Each pen contained a castrated, castrated plus drug, drug only, and a control (uncastrated, no drug) pig. The pigs were weighed and the proper dosage of drug was administered 30 min before the pigs were castrated. After the castration procedure, each pig assigned to a treatment was identified by a paint brand number placed on its back. Pigs were videotaped for a 24-h period with a black and white surveillance camera and a time-lapse video recorder (.83 frames/s recording speed). A digital timing and data summary program (McGlone et al., 1985) was used to measure the duration of each behavior. Behaviors were categorized as standing, lying, drinking, and feeding as previously described (McGlone and Hellman, 1988). The pigs were weighed before and 24 h after castration.

In Exp. 3, crystalline aspirin (acetylsalicylic acid, Sigma Chemical, St. Louis, MO) was placed in a water suspension and administered orally at a dosage of 22 mg/kg of BW (Booth, 1982). Behavioral data were collected on only 6 of the 10 litters because of technical problems with video taping of four litters.

In Exp. 4, butorphanol (butorphanol tartrate, Fort Dodge Laboratories, Fort Dodge, IA), at a dose of .11 mg/kg of BW (Fraser, 1991), was administered intravenously while the pig was held in lateral recumbency. The selected dose of butorphanol was the same as reported on the package insert for relief of pain in dogs and horses. Complete behavioral data were available on 8 of the 10 litters.

Statistical Analysis. Data were analyzed using the GLM procedure of SAS (1990). A randomized complete block design was used in all experiments for performance data. Litter was considered the block. Behavioral data were analyzed as a split plot in a randomized complete block design. In Exp. 1, the model was a split-split-plot design with two main-plot treatments (control vs castrated). Litters were blocks and time (6 h after treatment) was the first split and age was the second split. In Exp. 3 and 4, main effects of treatments were in a 2 × 2 factorial arrangement.

Results and Discussion

Experiment 1: Age Effects on Behavior. The age of pigs did not influence behavior of castrated or control pigs. No significant interactions between age and treatment ($P > .20$) were observed for behavioral measures. Castrated pigs showed a small, but significant, reduction (approximately 10% reduction) in

Table 1. Castration effects on pig behaviors (min/30-min period for 6 h after treatment) (Exp. 1)

Behavior	Treatment		SE
	Control	Castrated	
Suckling	4.78*	4.33	.14
Standing under heat	1.35**	.97	.08
Standing, not under heat	5.06	4.58	.16
Total standing time	6.41*	5.56	.19
Lying under heat	7.51	7.53	.30
Lying, not under heat	11.29	12.52	.31
Total lying time	18.80*	20.05	.22

*Control vs castrated differ, $P < .05$.
**Control vs castrated differ, $P < .01$.

time spent suckling (4.33 vs 4.78 ± .14 min/30 min, $P < .05$) compared to control pigs (Table 1). This effect was of statistically similar magnitude at each age (thus, no age × treatment interactions). In addition, castrated pigs spent less time standing ($P < .05$) and more time lying ($P < .05$) than did control pigs.

Experiment 2: Weights. Pig performance results are given in Table 2. The treatment effect was significant for birth weight. Males selected for castration on d 1 of age were heavier at birth than males selected for castration on d 14 of age ($P < .001$). Because of this effect, birth weight was included as a covariate for weaning weight and weight gain data. The treatment (females, males castrated on d 1, or males castrated on d 14 of age) effect was not significant for weaning weight and ADG ($P = .12$), but because of its weak trend, we used the *t*-test (predicted difference test) to determine whether males castrated on d 1 differed from males castrated on d 14 of age. Although males castrated on d 1 of age were heavier at birth, pigs castrated on d 14 of age were heavier ($P = .05$) at weaning than littermate males that were castrated on d 1 of age. Pig weight gain was greater ($P < .05$) when males were castrated on d 14 than when males were castrated on d 1 of age. Females were intermediate to males castrated on d 1 or 14 for weaning weight and lactation weight gain.

Experiments 3 and 4: Analgesics. Aspirin and butorphanol were evaluated in separate experiments for their effect on pig weight gain and behavior. The effect of drug (aspirin or butorphanol) did not influence weight gain ($P > .10$) and the interaction between drug and castration was not significant. In Exp. 3 (aspirin) pigs that were castrated gained less weight (.145 vs .254 ± .027 kg/24 h, $P < .05$) than pigs that were not castrated. In Exp. 4 (butorphanol), pigs that were castrated gained less weight (.173 vs .354 ± .027 kg/24 h, $P < .001$) than pigs that were not castrated.

Aspirin and butorphanol did not cause any measurable behavioral changes (Tables 3 and 4, respectively). Castrated pigs spent less time feeding ($P < .05$) than did control pigs. In Exp. 4, castrated pigs spent less time ($P < .05$) standing and drinking and more time ($P < .01$) lying than did uncastrated pigs. In Exp. 4. (only), the castration × time interaction was significant ($P < .01$) for feeding behavior (Figure 1a). In contrast, the castration × time effect was not significant ($P > .20$) for feeding duration in Exp. 3 (Figure 1b).

Singer (1990) has argued that there is no moral justification to consider the pain animals experience from a given procedure as any more or less important than the same pain experienced by humans. Thus, if a procedure performed on humans would use pain-reducing drugs or techniques, then the same procedure, performed on animals, would warrant the same pain-reducing procedure. Regardless of whether one accepts this philosophical view, as humane stewards livestock producers should seek to minimize pain among their animals during routine procedures.

The perception of pain by farm animals is poorly understood. Farm animals, particularly very young farm animals, may have a reduced pain perception because of an immature nervous system. Previous

Table 2. Performance measures from males castrated at day 1 or 14 of age and female littermates (Exp. 2)

Measure	Males		Females	*P*-value[a]	SE
	Day 1	Day 14			
No. born	191	214	339	—	—
No. at weaning	173	199	313	—	—
Death loss, %	9.4	7.0	7.7	NS[b]	—
Birth wt, kg	1.88[d]	1.74[e]	1.73[e]	.0004	.020
Weaning wt, kg[c]	7.19[d]	7.45[e]	7.38[de]	.12	.091
Average daily gain, kg[cf]	.186[d]	.195[e]	.193[de]	.12	.003

[a]*P*-value is for the treatment effect.
[b]NS = not different ($P > .20$).
[c]Birth weight was used as a covariate for weaning weight and average daily gain during lactation.
[d,e]Means with different superscripts differ ($P \leq .05$, using the predicted difference test within the LSMEANS procedure of SAS (1990).
[f]Average lactation period was 29 d.

Table 3. Castration and the effect of aspirin on behaviors (min/2-h period) of 8-week-old pigs (Exp. 3)

	Treatment				
	Control (no drug)		Aspirin-treated		
Item	Castrated	Intact	Castrated	Intact	SE
Behavior					
Feeding[a]	11.9	14.4	9.3	14.0	1.75
Drinking	1.2	1.4	.9	1.2	.19
Lying	100.1	98.1	104.5	99.6	2.33
Standing	6.9	6.1	5.2	5.2	.71
Performance					
24-h wt gain, kg[a]	.37	.62	.26	.51	.12

[a]Main effect of castration, $P \leq .05$. Drug and drug × castration effects were not significant. n = 24 animals.

data collected in our laboratory certainly are consistent with the hypothesis that 7-wk-old pigs are more sensitive to pain than are 2-wk-old pigs (McGlone and Hellman, 1988). Thus, we speculated that if pain perception developed between birth and 7 wk of age, then perhaps 1-d-old pigs would be even less affected by castration than older pigs (such as 10- to 21-d-old pigs). This was not the case.

Experiment 1 examined behavioral effects of castration for pigs between 1 and 20 d of age. Males showed similar behavioral effects of castration at all ages tested (1, 5, 10, 15, and 20 d of age). Still, as we reported previously, castration reduced suckling time and increased lying time (Table 1). These data imply that the pig's nervous system is as pain-perceptive at 1 d of age as it is at 20 d of age. Again, we found a much more striking effect of castration on older pigs' behavior (Table 3).

Without a more complete understanding of pain perception, livestock producers will have difficulty minimizing pain associated with certain standard practices. In the absence of a more complete understanding of pain perception, pork producers are likely to make their decision on age of castration based solely on pig performance data and other economic factors.

Caution is suggested when comparing data concerning the castration of other species. Mellor and Murray (1989) examined the effect of castration on the behavior of young lambs. Castrated lambs were more restless (frequent standing and lying down) during the first 60 min after castration. In a subsequent study comparing three farm species, Mellor et al. (1991) suggested that distress caused by castration was greatest in lambs, intermediate in young goats, and minimal in hand-reared calves.

Experiment 2 examined the effects of castration at d 1 or 14 of age on pig performance. In spite of attempts to randomize subjects, males selected for castration at d 1 of age were .14 kg ($P < .001$) heavier at birth than males castrated on 14 d of age (Table 2). Thus, birth weight was included as a covariate in the model that examined weaning weight and weight gain data. At weaning, males castrated at 1 d of age were

Table 4. Castration and the effect of butorphanol on behaviors (min/2-h period) of 8-week-old pigs (Exp. 4)[a]

	Treatment				
	Control (no drug)		Butorphanol-treated		
Item	Castrated	Intact	Castrated	Intact	SE
Behavior					
Feeding[b]	11.6	13.9	9.6	12.7	3.24
Drinking[b]	1.4	1.3	.8	1.7	.63
Lying[c]	103.7	100.2	105.7	99.2	4.35
Standing[b]	3.6	4.6	4.0	6.3	2.38
Performance					
24-h wt gain, kg[c]	.49	.81	.26	.75	.10

[a]Drug and drug × castration effects were not significant. n = 32 animals.
[b]Main effect of castration, $P < .05$.
[c]Main effect of castration, $P < .01$.

lighter than those castrated at 14 d of age, and females were intermediate in both weaning weight and weight gain. Hoy and Puppe (1992) suggested that the pig's activity level determines the efficiency of suckling. Reduced suckling behavior could decrease the amount of immunoglobulins ingested by the castrated male. Another consideration would be that castration decreased pig activity at a time when teat order is being established; thus, a pig castrated on d 1 may have obtained a less productive teat. In addition, because males castrated on d 1 may initially suckle less vigorously, the potential milk yield of that teat may be limited. Marks et al. (1988) found no advantage in weight gain when the performance of male pigs castrated at 1, 7, or 14 d of age was compared. There was a tendency ($P < .10$) for improved postweaning feed efficiency for pigs castrated on d 14 compared with pigs castrated on d 1. Additionally, pigs castrated on d 1 had more carcass backfat than pigs castrated on d 14. At this time, if all other cost factors are equal, pork producers may find a small advantage to castrating pigs at 14 d rather than at 1 d of age.

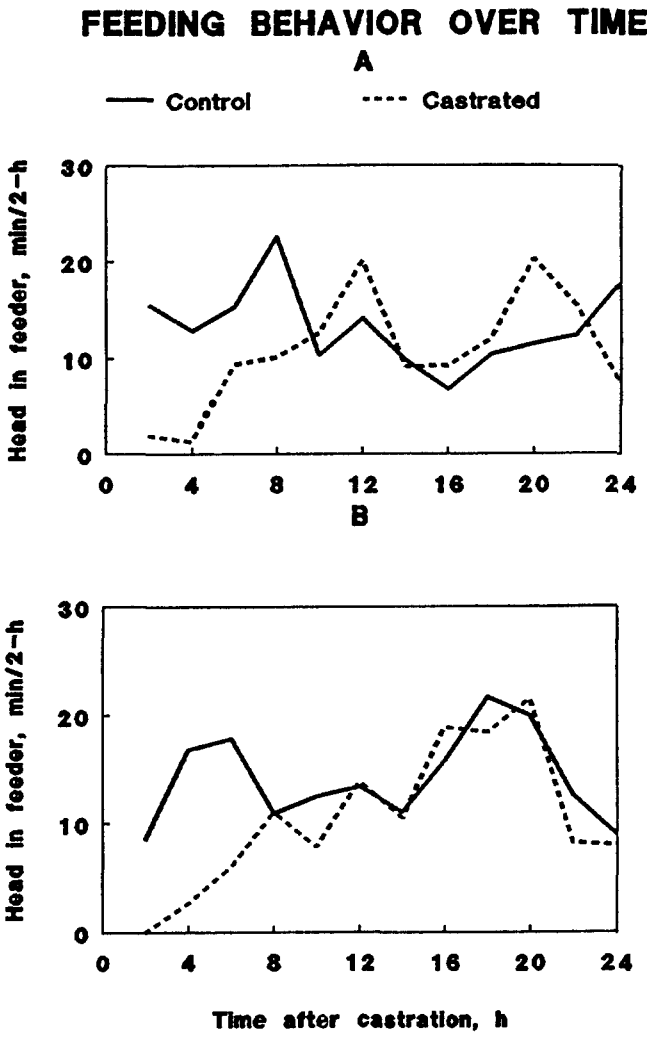

Figure 1. Feeding behavior, over time, for castrated and control pigs. Figure 1A is from Exp. 4 (butorphanol); castrated × time interaction, $P < .01$ (SEp = 3.1). Figure 1B is from Exp. 3 (aspirin); castration × time effect not significant (SEp = 3.8). In each experiment, the main effect of castration was significant, $P \leq .05$.

Different segments of the pork industry castrate at different ages. Seedstock producers, for example, may castrate pigs at an older age to get better estimates of genetic potential for boars. The industry is faced with an important question: if pigs must be castrated at an older age, what can be done to minimize the pain? Our previous work found local and general anesthetics to be ineffective at reducing castration-induced pain among 7-wk-old pigs (McGlone and Hellman, 1988). The present study was designed to examine analgesics.

The first problem with identification of potential analgesics for use in pigs is that, in the United States, the Food and Drug Administration has not approved an analgesic for use in pigs intended for slaughter (Sundlof et al., 1991). If analgesics were to become adopted, we hypothesized, a non-narcotic analgesic would be the analgesic of choice. Two common non-narcotic analgesics are aspirin and butorphanol. The dosage used for aspirin was based on recommendations for pigs, whereas the dosage for the use of butorphanol tartrate was based on recommendations for dogs.

The types of analgesics at the doses evaluated were ineffective at restoring pig behavior to the level of that of the uncastrated pigs. In fact, analgesics had no significant effect on any measure. Clearly, dose-response data are needed to identify some pain-reducing drug that may be efficacious if one attempted to reduce pain associated with castration. We are not aware of any effective analgesic for castration in pigs.

Implications

Pigs showed similar behavioral effects of castration whether castrated at 1, 5, 10, 15, or 20 d of age. Therefore, in terms of behavioral effects, pork producers should expect a small reduction in suckling time and an increase in lying time when pigs are castrated at any age from birth to 20 d of age. Pig weaning weights and weight gains may favor castrating at 14 rather than 1 d of age. The analgesics evaluated (at the doses tested) were ineffective in influencing the behavioral changes associated with castration. If pigs are to be castrated at ≥ 7 wk of age, no effective analgesics are available or approved for use by the U.S. Food and Drug Administration.

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