LOCAL AND GENERAL ANESTHETIC EFFECTS ON BEHAVIOR AND PERFORMANCE OF TWO- AND SEVEN-WEEK-OLD CASTRATED AND UNCASTRATED PIGLETS

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ABSTRACT

Four experiments were conducted to examine the effects of general and local anesthetics given prior to castration on piglet behavior and weight gain. The first experiment showed that use of general anesthesia by xylazine, ketamine hydrochloride and glyceryl guaiacolate for 2-wk-old piglets resulted in the death of 28% of the piglets and, for those that survived, suppressed nursing behavior. In the second experiment, using 2-wk-old piglets, local anesthesia by lidocaine hydrochloride prevented the slight (30 min) castration-induced nursing behavior suppression. In the third and fourth studies, using 7-wk-old pigs, local or general anesthetic did not overcome castration-induced changes in behavior. Castration affected behavior of 7-wk-old pigs for 6 to 8 h. None of the treatments in any of the studies influenced weight gain. We conclude that castration is painful for 2-wk-old and 7-wk-old pigs. The 2-wk-old pig seems behaviorally less affected by castration than does the 7-wk-old pig. Local anesthetic prevented pain-induced behavior changes for 2-wk-old, but not for 7-wk-old, pigs. At present, the FDA does not permit use of these anesthetics in meat-producing animals.
(Key Words: Pigs, Castration, Pain, Animal Welfare, Behavior, Anesthesia.)

Introduction

Every year, thousands of young male pigs are castrated to prevent their meat from being tainted with "boar odor" (the ordor normally present in post-puberal male pigs). Pork producers would rather not castrate because castration requires labor and intact boars produce leaner carcasses (Seideman et al., 1982).

Because the consumer discriminates against meat with a boar odor, pork producers perform this procedure. To minimize negative consequences of castration on pig performance and carcass quality, pork producers castrate their pigs at a young age. Anesthetics typically are not used when pigs are castrated.

The question of whether or not castration is painful has been addressed by Wemelsfelder and van Putten (1985). They concluded that castration is painful by observing that behavior was changed in castrated males compared with untreated females. However, finding a behavioral difference between treatments does not indicate that the change was caused by pain, even though castration appears painful. Instead, stronger evidence that a procedure is painful might be gathered if administration of a pain-reducing drug restores behavior of castrated-pigs to control level.

The objective of this study was to determine the effects of local and general anesthetics on behavior and performance of 2-wk-old and 7-wk-old piglets. In particular, we sought to determine if piglet behavior is measurably changed by castration and, if so, if anesthetics would reduce these effects of castration on piglet behavior and performance.

Materials and Methods

General. Pigs were derived from a four-breed rotational cross using Yorkshire, Duroc, Hamp-

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TABLE 1. DESCRIPTION OF BEHAVIORS

Age group and activity	Description
Two-wk-old piglets	
Missed nursing	Stayed away from teat and udder during nursing bout
Standing under heat	Stood under light of heat lamp
Lying under heat	Not supported by feet, under lamp
Standing away from heat	Stood not under light of heat lamp
Lying away from heat	Not supported by feet, not under lamp
Nursing	Participated in nursing including milk injection
Uncoordinated	Ataxia and thrashing about
Seven-wk-old pigs	
Feeding	Head in feeder
Drinking	Mouth around nipple waterer
Standing	Supported by feet
Lying	Not supported by feet
Eating bout	A period of feeding preceded by at least 10 min of nonfeeding behavior

shire and Landrace breeds. Sows had ad libitum access to a fortified, 13% CP sorghum grain-soybean meal diet during a 28-d lactation period.

Castration was performed when litters were either 10 to 14 d or 6 to 7 wk of age. A scalpel (disinfected with chlorhexidine) was used to make an incision an each side of the scrotum. A second incision on each side was made to free each testicle from the surrounding tissue. The testicle was then removed by pulling. A solution of 2% iodine was applied to the open wound, and the piglets were returned to their pen.

Four experiments were conducted. Performance data included pig weight at birth and weaning for the first two experiments and weight at weaning (4 wk) and 9 wk of age for the second two experiments. Weight gain was calculated over the experimental period within each experiment.

Piglets were video-taped[3] in time-lapse (.83 frames/s). The video records were replayed and an electronic event recorder[4] was used to summarize behavioral data (see Table 1 for list of behaviors). Treatments imposed on piglets were not revealed to observers, although some treatments were obvious (e.g., castration and general anesthesia).

Only male piglets were used. Handled, uncastrated males not treated with drugs are termed control pigs throughout the text.

Design and Analysis. Treatments were applied within litters. Each study was a split-plot, randomized complete block design with a 2 × 2 factorial arrangement of main effect treatments. Main effect treatments were 1) drug or no drug and 2) castration or no castration. The sows/litters were the blocks. Two time periods were used for 14-d-old piglets for behavioral measures: 3 h pre- and 3 h post-castration. For 7-wk-old pigs, time periods included 2 h pre- and 24 h post-castration. Performance data had a similar design and analysis, except these data were not analyzed as a split-plot design. Within an experiment, the control pigs' data were compared with each of the remaining three treatments (preplanned, nonorthogonal comparisons) using the predicted difference test within the GLM procedure of SAS (1985). Body weight changes were recorded between birth and weaning (28 d) in the first two experiments and between 4 and 9 wk of age for the third and fourth experiments.

Experimental Procedures. Four experiments were performed. The first two experiments involved general and local anesthetics in 2-wk-old piglets. The second two experiments involved general and local anesthetic effects on 7-wk-old pigs.

[3] Recorder Panasonic model AG-6010; camera model WV-3160; Panasonic Corp., Secaucus, NJ.

[4] Datamyte Model 800, Datamyte Corp., Minnetonka, MN.

In Exp. 1, general anesthetic was evaluated in 10- to 14-d-old castrated and control piglets in a 2 × 2 arrangement of treatments. The general anesthetic was a mixture of 25 ml (500 mg) of xylazine, 5 ml (500 mg) of ketamine hydrochloride and 500 ml of glyceryl guaiacolate (5%) administered at .5 ml/kg BW. The mixture was injected in the anterior vena cava while pigs were in lateral recumbancy. Piglets were castrated when fully under the effects of these drugs. After castration or no castration, piglets were returned to their farrowing crate (with their dams) and placed under the heat lamp. A total of nine litters containing four male pigs each (36 piglets total) were used.

Because some piglets died during Exp. 1, a supplementary experiment was conducted. Thirty 10- to 14-d-old piglets were injected in a manner identical to that described in Exp. 1 and 2 ml of a lactate Ringer saline solution. This was conducted to determine if the injection procedure per se caused piglet death. No behavioral measures were taken; only piglet mortality was measured. Mortality results cannot be compared directly because the supplementary study was performed after the main study.

In Exp. 2, the effects of local anesthetic or no injection were evaluated in castrated and control 2-wk-old piglets in a 2 × 2 arrangement of treatments. Lidocaine hydrochloride (2%) was injected (1.2 ml) into each side of the scrotum subcutaneously. After a 10-min delay, the same amount was injected into each testicle. After an additional 10 min, piglets were castrated. A total of eight litters containing four males each were used (32 pigs total).

In Exp. 3, treatments included administration of the general anesthetic (as described before) or no drug and castration or no castration (2 × 2 arrangement of treatments) in 6- to 7-wk-old pigs. Behavior was recorded for 2 h precastration and for 24 h postcastration. The longer video tapes were collected because earlier replicates indicated that pigs had not fully recovered from the effects of castration on behavior within 2 h posttreatment. Body weight was recorded at weaning (4 wk) and at 9 wk of age. Weight gain between weigh days was calculated. Nine pens of four male pigs each were used. The pens containing four littermate males were considered the experimental units for Exp. 3 and 4.

In Exp. 4, local anesthetic or nothing was administered to 7-wk-old pigs that were or were not castrated (2 × 2 arrangement of treatments). Anesthesia (same dose) and castration were performed as described previously. Video pictures and body weights were recorded as described in Exp. 3. Eight pens of four male pigs each were used.

Results and Discussion

Experiment 1. General, 14 D. Five of the 18 piglets given general anesthesia died within 24 h of drug treatment. These deaths may have been due to poor injection technique in the early stages of the experiment. Some of the piglets may have died from limited ability to metabolize or catabolize the anesthetic; further research would be needed to verify this hypothesis. None of the control piglets died after handling. In the supplementary study, none of the 30 piglets died following i.v. injection of a lactate-saline solution.

Piglet weights at each age were not influenced by treatments ($P > .10$; Table 2). Likewise, piglet weight gain was not influenced by treatments or their interaction.

The castration × time, castration × drug treatment and the castration × drug × time interactions were not statistically significant for any measurement in Table 3. The main effect due to drug treatment was significant for some measures; however, in each case, the anesthesia × time interaction was significant (Table 3).

Pigs given general anesthetic missed an average of 1.5 nursings in the 3-h period after anesthesia. Pigs in the other three treatment groups missed no nursings. Because piglets nursed about one time per hour, individual piglets missed one or two nursings because of drug treatment. Anesthetized piglets showed uncoordinated behavior as they came out of the anesthetic's effects. Strangely, one castrated piglet that did not receive any drug showed some uncoordinated behavior.

Anesthetized piglets spent less time nursing after drug application. The extra time spent away from nursing activity was spent largely in uncoordinated behavior. Time spent standing and lying under the heat lamp was not affected by treatments. Anesthetized piglets did spend less time lying away from the heat lamp than did piglets not treated with drugs.

These results indicate that use of general anesthetic had negative effects on piglets' survival and behavior especially heat lamp use.

Experiment 2. Local, 14 D. Listed in Table 4 are the means for the interaction between castra-

TABLE 2. EFFECTS OF TREATMENTS ON BODY WEIGHTS[a]

Item	N	No anesthesia		Anesthesia		SE_p[b]
		Castrate	Control	Castrate	Control	
Exp. 1 (General)						
Birth wt, kg	24	1.6	1.5	1.7	1.8	.30
14-d wt, kg	24	3.7	3.6	4.0	3.9	.27
28-d wt, kg	24	7.0	6.2	6.6	7.5	.84
Exp. 2 (Local)						
Birth wt, kg	20	1.5	1.5	1.7	1.3	.14
14-d wt, kg	20	2.8	2.8	3.2	3.2	.47
28-d wt, kg	20	5.6	6.5	7.1	6.3	.73
Exp. 3 (General)						
28-d wt, kg	11	6.1	6.8	6.1	6.9	.27
49-d wt, kg	21	11.9	12.5	12.3	12.5	.74
63-d wt, kg	21	18.5	19.3	18.8	19.3	1.08
Exp. 4 (Local)						
28-d wt, kg	28	7.6	7.2	7.6	7.4	.43
39-d wt, kg	28	14.8	15.0	13.3	14.1	1.09
63-d wt, kg	28	22.9	19.8	20.8	22.5	1.53

[a]Main effects and interactions, $P > .10$.

[b]Pooled SE.

tion and drug treatments. Where the interaction was significant, the predicted difference test (SAS, 1985) was used to determine which means differed ($P < .05$) from controls.

Piglets that were castrated without local anesthesia nursed for 8.6% shorter duration than control piglets ($P < .05$; Table 4). Piglets that were castrated under the influence of local anesthesia nursed for a duration similar to that of control piglets. Local anesthesia alone resulted in nursing duration similar to control level. Although anesthesia increased nursing duration for castrated pigs, anesthesia had no significant effect on nursing duration of uncas-

TABLE 3. EFFECTS OF GENERAL ANESTHESIA ON BEHAVIOR (MEAN ± SE, MIN) BEFORE AND AFTER DRUG TREATMENTS[a]

Behavior	Anesthesia		No anesthesia		*P*-values for interaction[c]
	Pre[b]	Post[b]	Pre[b]	Post[b]	
No. missed nursing	0 ± 0[d]	1.5 ± .13	0 ± 0[d]	0 ± 0[d]	[e]
Standing under heat	4.3 ± .43	4.0 ± .45	3.8 ± .32	3.2 ± .37	NS[f]
Lying under heat	6.5 ± .68	8.0 ± 1.17	6.5 ± .95	9.1 ± 1.00	NS
Standing away from heat	21.0 ± .99	18.0 ± 1.5	21.8 ± 1.22	21.5 ± 2.04	NS
Lying away from heat	124.2 ± 1.31	108.5 ± 1.78	124.9 ± 1.34	119.8 ± 2.75	.001
Nursing	23.9 ± .88	18.5 ± 1.04	23.0 ± .69	24.3 ± .93	.0001
Uncoordinated	0 ± 0[d]	22.4 ± 1.46	0 ± 0[d]	1.3 ± 1.33	[e]

[a]N = 13 to 15 observation per treatment mean.

[b]Pre refers to time before drug was given; Post refers to time after drug and after castration. Each period was 3 h. Means are averaged over castration treatments.

[c]Interaction between drug treatment and period.

[d]No missed nursings or uncoordinated behavior were observed.

[e]Because some treatments were all zero (with zero variation), a statistical analysis was not performed.

[f]NS = not significant.

TABLE 4. EFFECTS OF LOCAL ANESTHESIA AND CASTRATION ON PIGLET BEHAVIOR[a]

Behavior	Castrated		Not castrated		SE_p	P-value for interaction[c]
	Anesthesia	No anesthesia	Anesthesia	No anesthesia[b]		
Standing under heat	3.6	2.8	2.7	3.1	.62	NS[e]
Lying under heat	6.4	7.1	7.0	6.4	.97	NS
Standing away from heat	21.0	17.6[d]	18.8	21.4	1.09	< .10
Lying away from heat	127.4	133.2[d]	131.4	127.5	2.01	< .05
Nursing	22.4	19.2[d]	20.3	22.2	.70	< .10

[a]Mean, min/3 h, n = 16 observations per treatment mean averaged over two measurement times; SE_p = pooled SE.

[b]Considered control treatment. Absence of superscript within a row denotes statistical similarity to control mean.

[c]Interaction between drug and castration treatments.

[d]Differed from control, $P < .05$.

[e]NS = not significant.

trated pigs. A similar trend may be seen in the data for standing and lying away from the heat lamp. Piglets that were castrated and received no local anesthetic tended to nurse less time and spent that extra time lying away from the heat lamp. Local anesthetic restored nursing and maintenance behaviors (such as lying and nursing) of castrated 10- to 14-d old pigs to the level of uncastrated, unanesthetized piglets.

Weight gain and survival were similar among treated piglets. The three-way interaction (drug × castration × time) was not statistically significant for any behavior presented in Table 4. In addition, interactions between time and treatments were not significant.

Piglet weights, weight gain and survival were not influenced ($P > .10$) by any treatment or interaction among treatments (Table 2). In addition, no injection-related injuries were observed.

Experiment 3. General, 7 Wk. The castration × time interaction was significant for all measures of pig behavior (see Table 5). The duration of feeding and drinking and number of feeding bouts were suppressed by castration (compared with non-castration). To a smaller degree, lying duration was increased by castration. Changes in behavior due to castration lasted 8 h for feeding and drinking but only 6 h for lying duration.

The anesthesia × time interaction was significant for feeding behavior. Pigs given the general anesthetic had suppressed feeding behavior for the first 2 h after drug application.

The castration × anesthetic × time interaction values for feeding behavior are presented in Figure 1. The longer-term effects of castration on feeding behavior are obvious (comparing control, N+N, with castration treatments). Also, comparing pigs that received no anesthetic with pigs receiving only the general anesthetic (N+A; Figure 1), one can see that the general anesthetic alone suppressed feeding behavior during the first 2-h period after drug administration. Therefore, the general anesthetic may have worn off by 4 h after administration, whereas the effects of castration lasted 6 to 8 h. Other behaviors (not shown) exhibited similar tendencies.

Treatments (general anesthetic and castration) and their interaction did not influence ($P > .10$) pig weight or weight gain from weaning to 9 wk of age. No pig deaths occurred in any treatment group. Thus, castration had no lasting influence on economically important measures taken in this study.

Experiment 4. Local, 7 Wk. As in Exp. 3, the castration × time interaction was significant (see Table 6). Other interactions were not significant. Data showed significant effects similar to those identified in Exp. 3. Castration suppressed feeding, drinking and eating bouts for 6 h. Concomitantly, lying time was increased during the 0-to-6-h postcastration period.

Figure 2 shows the suppression in feeding behavior for 6 h postcastration. This suppression in feeding behavior due to castration was not overcome by administering local anesthetic (note C+A vs C+N).

Pig weight gain was not influenced by local anesthetic or castration main effect or interaction (Table 2). Treatments had no influence on economically important measures.

Discussion

The general anesthetic used in this study was contraindicated, especially for 14-d-old piglets. Piglets receiving the general anesthetic missed an average of 1.5 nursing bouts during the 3 h after treatments. Control piglets did not miss any nursings, regardless of whether or not they were castrated.

Castration had measurable effects on behavior of pigs at both ages tested. The 14-d-old piglets showed a suppression in nursing dura-

TABLE 5. EFFECTS OF CASTRATION ON BEHAVIOR (MIN/2 H) OF SEVEN-WEEK-OLD PIGS AVERAGED OVER GENERAL ANESTHESIA OR CONTROL TREATMENTS[a]

2-h periods[b]	Feeding	Drinking	Standing	Lying	Eating bouts
			Castrated		
−2	28.5	4.0	21.1	66.9	3.4
2	1.9[e]	.6[e]	15.7	85.6	.7[e]
4	1.4	.2[e]	7.2	110.5[e]	.4[e]
6	2.7[e]	.5[e]	4.8	112.0[e]	.6[e]
8	10.4[e]	1.6[e]	7.5	99.5	1.8[e]
10	11.1	1.0	10.5	97.3	1.8[e]
12	15.4	1.6	10.0	92.9	2.4[e]
14	15.1	1.4	9.9	85.3	2.3
16	21.2	3.1	9.4	86.3	3.4
18	14.4	2.0	9.2	94.4	2.7
20	15.0	1.4	10.7	92.9	2.9
22	16.8	1.8	11.6	89.8	2.7
24	19.7	2.6	11.5	86.2	3.4
			Not castrated		
−2	27.4	3.6	20.1	68.8	3.4
2	12.2	1.7	17.5	80.0	1.9
4	12.5	1.2	9.9	94.5	2.6
6	16.5	1.9	8.4	95.2	3.1
8	19.6	2.4	12.2	85.9	3.6
10	16.1	1.7	13.0	89.3	3.6
12	20.4	2.8	9.9	87.0	3.9
14	14.2	1.6	9.5	94.8	2.5
16	19.5	2.1	11.3	79.3	3.4
18	20.0	2.0	12.3	85.7	3.2
20	17.2	2.4	10.9	90.1	3.3
22	18.4	1.6	10.4	89.6	3.1
24	15.6	1.5	11.5	91.5	3.4
Pooled SE	2.05	.35	1.13	3.63	.27
P-value[c]	.0002[d]	.005	.06	.007	.0001

[a]N = 10 to 16 per mean.

[b]Castration was performed at time zero.

[c]Castration × time effects.

[d]Anesthesia × time, $P = .02$.

[e]Mean differs from corresponding mean in not castrated data, $P < .01$.

tion (Table 4) after castration. However, the suppressed nursing time among castrated pigs was not so severe as to cause any missed nursing bouts. The 7-wk-old pigs showed suppressed feeding and drinking times and increased lying times for 6 to 8 h after castration. Increased lying time among castrated 4-wk-old pigs was documented previously by Wemelsfelder and van Putten (1985).

The 7-wk-old pigs' behavior was changed for a greater duration than was the behavior of 14-d-old piglets. This may have been due to a reduced sensitivity to pain in the younger pig. Further research is needed to document the development of pain sensitivity in the pig.

The local anesthetic prevented the castration-induced suppression in nursing behavior and the increase in lying away from the heat source for the 14-d-old piglet (Table 4). Because the behavioral change due to castration was relatively brief for the 14-d-old piglet, the local anesthetic, which also had a brief duration, was apparently effective. However, because longer-lasting behavioral records were not collected in the first two experiments, we conclude cautiously that the local anesthetic was effective at restoring castrated 14-d-old piglet behavior to control level. With larger numbers of observations of longer duration, smaller changes in piglet behavior may be detected.

Wemelsfelder and van Putten (1985) conducted an extensive study of the behavioral effects of castration. In addition to lying time, they documented pig vocalizations and wound healing. First, the handling of the pig caused increased vocalization. Cutting the scrotum and other membranes did not cause any additional change in the pigs' sonograms; however, when the spermatic cord was severed, they observed a change in vocalization, which they attributed to pain. Immediately following castration, the increase in lying time indicated postcastration

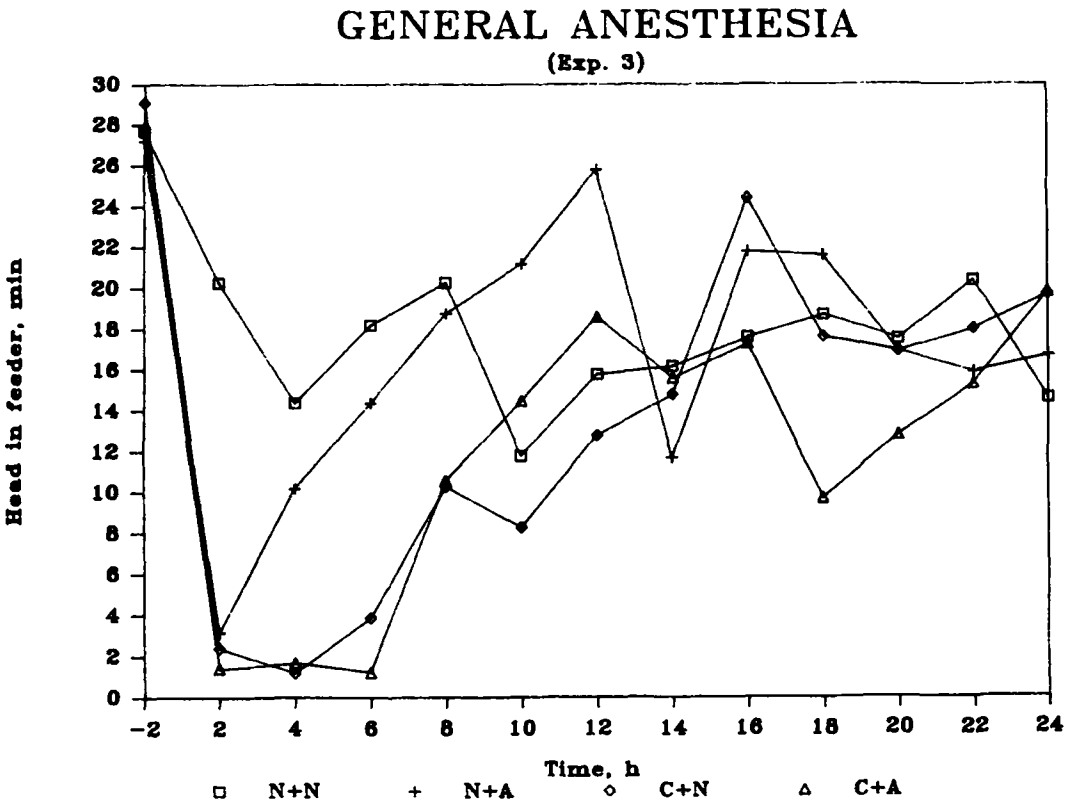

Figure 1. Effects of general anesthesia and castration on 7-wk-old pig feeding duration. Castration suppressed feeding time during the 2 to 8 h periods. A = general anesthetic, c = castrated, N = non-handled or non-anesthetized. Pooled SE = 3.0 min.

pain. Wound swelling and healing was the final and longer (2-wk) result. This progression corresponds to acute and chronic phases of pain (Kitchell and Johnson, 1985). Our study addressed only the acute phase.

The Wemelsfelder and van Putten (1985) study can be criticized for two reasons, although their conclusions are supported fully by our results. First, they used untreated female pigs as controls for castrated males. Second, changes in behavior and physiology cannot be attributed to pain simply because behaviors differ between treated and untreated piglets. Administration of a drug known to suppress pain that returns behavior of treated pigs to control levels would be stronger evidence of a painful procedure. Using this argument and our data, we conclude that the 14-d-old piglet experienced pain (for about 30 min) after castration and that a local anesthetic eliminated this pain. The 7-wk-old pig experienced behavioral changes for over 6 h after castration. These behavioral changes were not returned to a control level by local or general anesthesia.

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TABLE 6. EFFECTS OF CASTRATION ON BEHAVIOR (MIN/2 H) OF SEVEN-WEEK-OLD PIGS AVERAGED OVER LOCAL ANESTHESIA OR CONTROL TREATMENTS[a]

2-h periods[b]	Feeding	Drinking	Standing	Lying	Eating bouts
	Castrated				
−2	25.7	3.6	23.0	64.5	2.9
2	1.7[d]	.7[d]	8.6[d]	108.9[d]	.4[d]
4	5.5[d]	1.0[d]	11.1	102.4[d]	1.1[d]
6	7.1[d]	.8[d]	11.7	100.4[d]	1.4[d]
8	10.0	1.3	11.8	96.1	2.3
10	17.0	2.4	11.7	88.9	2.8
12	19.8	2.0	14.7	85.4	3.5
14	17.3	2.1	13.0	88.3	3.4
16	12.3	1.9	12.2	93.5	3.5
18	15.0	1.5	14.5	89.0	3.2
20	15.5	1.8	11.2	91.7	2.9
22	14.7	1.8	13.7	90.4	2.9
24	15.5	2.1	13.7	88.0	3.2
	Not castrated				
−2	25.0	2.9	21.0	67.9	3.1
2	15.9	2.3	15.0	86.4	3.1
4	18.2	2.4	11.2	88.1	3.1
6	17.8	2.4	13.2	85.9	3.3
8	12.0	1.7	12.3	94.1	2.6
10	15.4	1.6	13.6	89.3	3.4
12	16.0	2.4	11.9	89.7	3.3
14	15.7	2.1	10.5	91.6	3.0
16	11.3	1.5	12.4	94.1	2.5
18	15.2	1.9	11.6	91.3	3.0
20	17.1	1.7	12.1	89.1	3.2
22	16.8	2.3	11.7	89.4	3.3
24	16.2	1.9	11.6	90.4	3.2
Pooled SE	1.81	.33	1.34	2.84	.26
P-value[c]	.0001	.0007	.06	.001	.0001

[a]N = 14 to 20 per mean.

[b]Castration was performed at time zero.

[c]Castration X time effect.

[d]Mean differs from corresponding mean in not castrated data, $P < .01$.

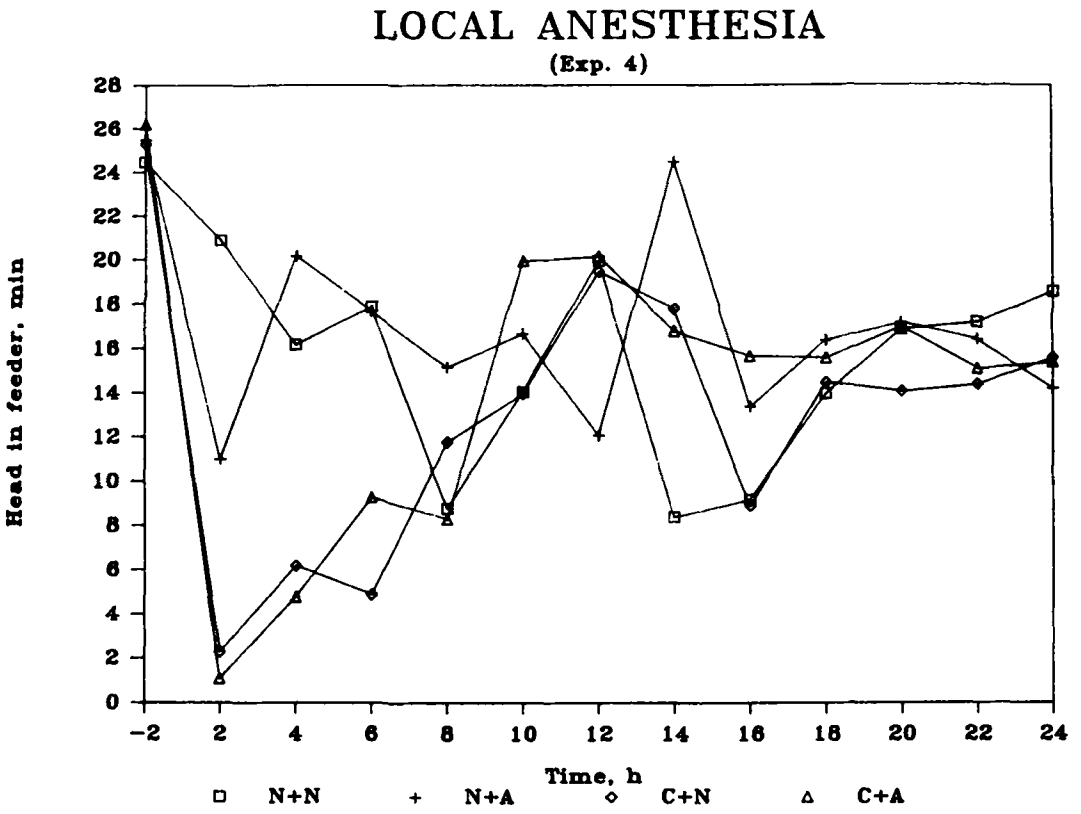

Figure 2. Effects of local anesthesia and castration on 7-wk-old pig feeding duration. Castration suppressed feeding time during the 2 to 6 h periods. A = local anesthetic, C = castrated, N = non-handled or non-anesthetized. Pooled SE = 2.7 min.

Research and Teaching (Consortium, 1988) states that when pigs are castrated after 2 mo of age, consideration should be given to use of anesthesia. In addition, animal castration is categorized by the popular press among the most pressing animal welfare concerns. Based on the results reported here, and government drug regulations, we see several problems. First, traditional application of general or local anesthesia may not be sufficient to eliminate pain in castrated pigs—especially in pigs older than 7 wk of age. Second, even a 2-wk-old pig seems to experience some pain associated with castration. Currently, the U.S. Food and Drug Administration has approved only aspirin as a pain-reducing drug for pigs destined for human consumption.

The intact male has benefits and problems as an agricultural animal (Seideman et al., 1982). The U.S. meat industry currently favors use of the castrated male over the intact male. If we desire to minimize pain associated with castration, male pigs should be castrated at a young age (e.g., 2 wk or younger). The general anesthetic we tested was not suited for the 10- to 14-d-old piglet. Local anesthetic provided some benefit (in terms of piglet behavior) for the 10- to 14-d-old piglet but was not fully effective for the 7-week-old pig. More research is needed to document development of pain and effectiveness of pain-reducing drugs for pigs.

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