ORAL ADMINISTRATION OF A 12% SUCROSE SOLUTION DID NOT DECREASE BEHAVIOURAL INDICATORS OF DISTRESS IN PIGLETS UNDERGOING TAIL DOCKING, TEETH CLIPPING AND EAR NOTCHING

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Abstract *Animal Welfare 2002, 11*: 395-404

Sucrose has been shown to attenuate the behavioural response to painful procedures in human infants undergoing circumcision or blood collection via heelstick. Sucrose has also been found to have a behaviour-modifying effect in neonatal rats exposed to a hot plate. The effect was abolished in neonatal rats by injection of the opioid antagonist naltrexone, suggesting that it was mediated by endogenous opioids. In this experiment, the behaviour of 571 newborn Large White × Landrace hybrid piglets in a specific-pathogen-free piggery of the University of Queensland was recorded during and after the routine management practices of tail docking, ear notching and teeth clipping. Piglets were randomly assigned to receive 1.0 ml of a 12% sucrose solution (treatment group) or a placebo (1.0 ml of air) administered via syringe in the mouth, 60 s before commencement of one of the management procedures. Behaviours were recorded at the time of the procedure, and then 2 min after completion of the procedure. Piglets that received the sucrose solution did not behave significantly differently from piglets receiving the placebo. Regardless of whether sucrose or placebo was administered, piglets undergoing the routine management procedures showed significantly greater behavioural responses than piglets undergoing no procedure. It was concluded that under commercial conditions, a 12% sucrose solution administered 1 min prior to surgery was not effective in decreasing the behavioural indicators of distress in piglets undergoing routine management procedures. Further research into methods of minimising distress caused to piglets by these procedures is recommended.

Keywords: *analgesia, animal welfare, piglets, sucrose, tail docking, teeth clipping*

Introduction

In many piggeries, tail docking and teeth clipping are routinely carried out on piglets in the first few days after birth. Teeth are clipped to reduce injuries to other piglets and to the teats of the sow. Tails are docked to discourage tail biting, which can cause economic loss from reduced weight gain and condemnation of carcasses at slaughter (Penny & Hill 1974). Other

routine management procedures performed in intensive piggeries include ear notching to permanently identify the pigs.

The practice of tail docking has received attention from the public and media because it is regarded by those concerned about animal welfare as painful and cruel (Senate Select Committee 1990). It has also been argued that docking is unwarranted as a preventive measure, because outbreaks of tail biting still occur in pigs that have been docked (England & Spurr 1967; Penny & Hill 1974; Blackshaw 1981; Fraser 1987). Tail docking has been banned in some European countries, including England, but continues to be performed under veterinary supervision in herds where tail biting is a problem. In many countries it continues to be performed as a routine management procedure.

Tail docking, teeth clipping and ear notching are performed in newborn piglets without the benefit of anaesthesia or analgesia. Until recently, it was thought that neonates did not experience pain, either because their nervous systems were not fully developed at birth or because the nerve pathways were not sufficiently myelinated to transmit painful stimuli (Katz 1977). However, more recent research appears to have disproved both these arguments. The anatomical structures needed to perceive pain are present while still in gestation (Owens 1984), and neonatal rats and humans show physiological responses consistent with pain perception (Kehoe & Blass 1986; Blass & Hoffmeyer 1991).

A study of the behavioural responses of piglets to tail docking, teeth clipping and ear notching has shown that there are significant differences in the behaviour of piglets subjected to these routine management procedures compared with control piglets that are handled only (Noonan *et al* 1994). The findings suggested that these procedures cause significant distress to the piglets. Although the assessment of pain or distress experienced by an animal is difficult, observation of behavioural changes is regarded by many researchers to be a legitimate method (Wiepkema 1983; Morton & Griffiths 1985; Tranquilli & Raffe 1989).

In studies of human infants undergoing minor surgical procedures such as circumcision or collection of blood via heel lance, administration of oral sucrose has been shown to significantly decrease the behavioural response (crying) to the procedure (Blass *et al* 1989; Blass & Hoffmeyer 1991). It was concluded that administration of sucrose was an excellent method of providing analgesia for infants undergoing routine stressful or painful procedures (Blass & Hoffmeyer 1991). Oral sucrose has also been reported to have analgesic properties in infant rats (Blass *et al* 1987; Blass & Fitzgerald 1988).

The objective of this study was to determine whether oral sucrose diminished the behavioural indicators of distress in piglets undergoing tail docking, teeth clipping and ear notching. If oral administration of sucrose to newborn piglets was found to significantly decrease behaviours associated with distress, it would be a simple and inexpensive method of reducing the distress caused by routine management procedures.

Materials and methods

Animals

A total of 571 Large White × Landrace hybrid piglets from 59 litters produced at the University of Queensland's specific-pathogen-free piggery at Pinjarra Hills were used in the study. All piglets used in the study were 1–3 days old, and were selected from litters containing six or more littermates.

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Behavioural criteria

Prior to the study, observations were made of piglets undergoing tail docking, ear notching and teeth clipping in order to define behavioural criteria suggestive of the duration and severity of pain, such as length and intensity of vocalisation, head shaking, and time to sleep. The definitions for these behaviours are given in Table 1. During the study, the same two research assistants observed the piglets and recorded their behaviour. The research assistants were blinded to the treatment received by the piglets.

Table 1 Definitions of behaviours observed during and after the management procedures.

Behaviour observed	Definition
Vocalisation: squeal	Intense, strident and prolonged vocalisation; often uncomfortable for the human observer to be close to the piglet.
Vocalisation: grunt	Milder, less strident and more guttural form of vocalisation, often repeated and more frequent than a squeal.
Teeth champing	Opening and closing of the mouth.
Head shaking	Vigorous toss of head from side to side, flapping of ears.
Tail flick	Flicking tail from side to side or up and down.
Tail jamming	Clamping of tail stump between the hind limbs without side to side movement.
Teat seeking	Piglet repeatedly nudging flank of sow and taking teat into mouth for <5 s.
Lying	Piglet lying on floor, on other piglets, or on sow's flank.
Sleep position*	Distinct from 'lying' with closure of both eyelids for period of >30 s.
Udder mouthing*	Purposeful nuzzling of the flank and teat area of a prostrate sow, piglet actively suckling on one teat for period >5 s; letdown of milk (as indicated by the sow calling the piglets) did not occur in all cases.

*Recording of individual piglet behaviour was terminated when these behaviours were observed.

Experimental procedure

The litter to be studied was randomly allocated to one of five different procedure options: teeth clipping only; tail docking only; ear notching only; teeth clipping, tail docking and ear notching; or no procedure. Within a litter, all piglets underwent the same procedure(s). Piglets in the 'no procedure' group did not have a management procedure performed; they were picked up and held, and then put down 60 s after administration of sucrose or placebo. The number of piglets in each of the groups was as follows: teeth clipping only, n = 60; tail docking only, n = 58; ear notching only, n = 58; teeth clipping, tail docking and ear notching, n = 57; no management procedures, n = 58. One operator performed all of the procedures.

Procedure for teeth clipping

The selected piglet was caught by a hind leg and cradled on one arm while the side-cutters for teeth clipping and tail docking were picked up. The piglet was then suspended in one hand, with the operator's thumb under the angle of the lower jaw on one side and the fourth or fifth finger pressing the other side of the jaw. The index finger was used to open the piglet's mouth by gentle pressure on the angle of the jaw and cheek. The finger did not enter the mouth. Side-cutters were introduced to the front of the mouth and following the jaw line, four quick snips removed the eight teeth. The procedure was routinely completed in less than four seconds.

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Procedure for tail docking
The piglet was again cradled on one arm (head towards the elbow). The tail was held between the thumb and forefinger of the arm the piglet was resting on. Side-cutters were used to crush and cut the tail, removing one third of it, with minimum blood flow. This procedure was performed in less than two seconds.

Procedure for ear notching
The piglet was cradled on the forearm. The ear was held between thumb and forefinger. Commercial piglet notching pliers were used to remove a v-shaped notch, 3 mm deep and 2.5 mm wide at the base. The maximum number of notches on any edge of the ear was three.

Treatment regimens
Piglets within the litter were randomly allocated to receive either 1 ml of 12% weight/volume oral sucrose solution (sucrose) or placebo (1 ml of air), administered via a 2 ml syringe into the mouth 60 s before commencement of the management procedures. The piglet's mouth was opened by the same technique as for teeth clipping, and medication deposited on the back of the tongue. The 60 s time interval between administration of the sucrose and commencement of the procedure was chosen on the basis of earlier studies of the use of sucrose in human and rat infants (Blass & Hoffmeyer 1991). Air was used as the placebo substance rather than water, because previous studies have shown that the administration of water can produce a similar, but less potent, endorphin-mediated analgesia to that obtained with sucrose (Blass *et al* 1987; Blass & Hoffmeyer 1991).

Comparison of behaviours during the procedure
During the study, each piglet was picked up and either sucrose or placebo administered orally. Sixty seconds later the procedure was performed and the piglet returned to the floor of the farrowing pen. The time taken for each procedure to be carried out was recorded. During each procedure, the variables recorded were the number of grunts, squeals and tail flicks (Table 1). Piglets in which no procedure was performed were not evaluated during this period.

Comparison of behaviours after completion of the procedure
After completion of the procedure, the piglet was placed on the floor, and the number of behavioural responses of the piglets for grunting, teeth champing, tail jamming, tail flicking, head shaking and lying were recorded in each 5 s interval for the first minute, and then in each 10 s interval until an end point (ie sleep position or udder mouthing) was reached. Piglets in which no procedure was performed had the same data collected from the time they were returned to the floor.

At the end of the experiment the piglets were weighed. Management practices at this piggery required all piglets to have their teeth clipped, ears notched and tails docked and to be injected with an iron solution. Thus, the procedures that were not carried out during the study were performed at the conclusion of the observation period.

Statistical analysis
To account for the difference in time taken to perform the various procedures, the number of behaviours recorded during the procedure was divided by the time the procedure took, to give the number of behaviours per second during the procedure (for example, the grunt frequency). For each 30 s period after completion of the procedure, the numbers of behaviours in each 5 s or

10 s interval were summed to give the total number of behaviours in each 30 s period for the first 2 min after the procedure; these total numbers were then used for analysis. During and after the procedure, the behavioural responses of piglets undergoing the same procedure were compared between the piglets that received sucrose and those that received placebo (air) using analysis of variance (SAS, Version 5, SAS Institute Inc, Cary, North Carolina, USA). Standard errors of the means (see Tables 2 and 3) were derived from the error terms in the analysis of variance. Behaviours of piglets undergoing no procedure were also compared between piglets receiving sucrose and those receiving placebo using analysis of variance. Time to sleep or udder mouthing were also compared between treatment groups. The effects of age and body-weight on the behavioural responses were examined individually using these variables as covariates.

Results

There was no significant difference between piglets given sucrose or placebo in the mean number of behaviours observed per second during the procedure (Table 2). In addition, after completion of the procedure, in the first 2 min after the piglets were placed on the floor, there was no statistical difference in the mean number of behaviours observed for each 30 s interval between piglets given placebo and piglets receiving sucrose (Tables 3 and 4).

Table 2 Mean and standard error of mean (SEM) for behavioural frequencies recorded during the procedure.

Behaviour	Procedure	Sucrose		Placebo	
		Mean behaviour frequency*	SEM	Mean behaviour frequency*	SEM
Grunt	Teeth clipping	0.35	0.16	0.27	0.04
	Tail docking	0.51		0.56	
	Ear notching	0.13		0.14	
	Teeth clipping, tail docking and ear notching	0.23		0.18	
Squeal	Teeth clipping	0.39		0.49	
	Tail docking	0.54		0.59	
	Ear notching	0.54		0.55	
	Teeth clipping, tail docking and ear notching	0.37		0.42	
Tail flick	Teeth clipping	0.01		0.01	
	Tail docking	0.04		0.04	
	Ear notching	0.01		0.01	
	Teeth clipping, tail docking and ear notching	0.04		0.04	

*Behaviour frequency = number of times behaviour observed during procedure divided by time taken for procedure. Sucrose = 1 ml 12% sucrose by mouth; Placebo = 1 ml air by mouth.

When the time taken for the piglets to sleep or feed was analysed amongst piglets undergoing the same procedure, there were no significant differences between the sucrose or placebo groups. The analysis of age and body-weight of the piglet as covariates revealed no significant effect on the behavioural response to the procedures.

For all behaviours except grunting, the frequency of behaviours in the 'no procedure' group was very low, and not significantly different between sucrose and placebo groups. After completion of the procedure, in the first 2 min after the piglets were placed on the floor, grunting was not significantly different between any procedure group or when compared with piglets in which no procedure had been performed. There were significant differences between piglets

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undergoing procedures and 'no procedure' piglets in behaviours other than grunting during the 2 min after the procedure (Tables 3 and 4). The differences in behaviours between procedures have been reported previously as part of a study of behaviours associated with routine management procedures in piglets (Noonan *et al* 1994), and are summarised in the discussion.

Table 3 **Mean and SEM for behaviours occurring in the periods 0–30 s and 30–60 s after the management procedure. There were no significant differences between sucrose and placebo (air) groups.**

Behaviour	Procedure	Time after the management procedure							
		0–30 s				30–60 s			
		Sucrose		Placebo		Sucrose		Placebo	
		Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
Grunt	Teeth clipping	3.28	1.0	3.50	0.57	0.78	0.23	0.04	0.29
	Tail docking	5.05	1.0	6.11		0.66	0.24	1.27	
	Ear notching	5.22	1.0	5.04		0.35	0.24	0.59	
	Teeth clipping, tail docking, ear notching	4.04	1.0	4.60		0.19	0.24	1.18	
	No procedure	3.07	1.0	2.86		0.57	0.24	0.50	
Squeal	Teeth clipping	0.0	0.2	0.0	—	0.0	0.02	0.0	—
	Tail docking	0.38	0.2	0.36		0.05		0.04	
	Ear notching	0.02	0.2	0.0		0.0		0.0	
	Teeth clipping, tail docking, ear notching	0.0	0.2	0.0		0.0		0.0	
	No procedure	0.0	0.2	0.0		0.0		0.0	
Tail flicking	Teeth clipping	0.82	0.9	0.50	0.19	0.23	0.37	0.50	0.15
	Tail docking	2.6	0.9	2.70		1.14	0.38	1.05	
	Ear notching	0.9	0.9	0.69		0.53	0.38	0.25	
	Teeth clipping, tail docking, ear notching	1.83	1.0	1.70		0.68	0.38	0.96	
	No procedure	0.22	0.9	0.34		0.22	0.38	0.18	
Tail jamming	Teeth clipping	0.0	1.0	0.0	0.18	0.0	0.48	0.0	0.16
	Tail docking	1.90	1.1	1.60		0.79	0.49	1.07	
	Ear notching	0.03	1.1	0.0		0.0	0.49	0.0	
	Teeth clipping, tail docking, ear notching	1.95	1.1	1.90		0.98	0.49	0.91	
	No procedure	0.0	1.1	0.0		0.0	0.49	0.0	
Teeth champing	Teeth clipping	1.95	0.8	1.50	0.15	1.8	0.73	0.84	0.12
	Tail docking	0.16	0.8	0.11		0.24	0.75	0.11	
	Ear notching	0.21	0.8	0.02		0.33	0.75	0.04	
	Teeth clipping, tail docking, ear notching	1.21	0.8	0.64		1.33	0.75	0.51	
	No procedure	0.22	0.8	0.04		0.19	0.75	0.13	
Head shaking	Teeth clipping	0.1	0.2	0.07	0.07	0.02	0.16	0.02	0.04
	Tail docking	0.0	0.2	0.02		0.03		0.0	
	Ear notching	0.41	0.2	0.66		0.38		0.09	
	Teeth clipping, tail docking, ear notching	0.37	0.2	0.36		0.12		0.15	
	No procedure	0.07	0.2	0.05		0.0		0.0	

Sucrose = 1 ml 12% sucrose by mouth; Placebo = 1 ml air by mouth

Discussion

In an associated study of behavioural responses of piglets to the management procedures of tail docking, teeth clipping and ear notching, there were three significant findings (Noonan 1994; Noonan *et al* 1994). First, the behaviour of those piglets that underwent a procedure

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Table 4 **Mean and SEM for behaviours occurring in the periods 60–90 s and 90–120 s after the management procedure. There were no significant differences between sucrose and placebo (air) groups.**

Behaviour	Procedure	Time after the management procedure							
		60–90 s				90–120 s			
		Sucrose		Placebo		Sucrose		Placebo	
		Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
Grunt	Teeth clipping	0.22	0.07	0.02	0.16	0.0	0.06	0.0	0.11
	Tail docking	0.12		0.33		0.12		0.0	
	Ear notching	0.1		0.34		0.09		0.0	
	Teeth clipping, tail docking, ear notching	0.03		0.36		0.0		0.0	
	No procedure	0.12		0.21		0.86		0.0	
Squeal	Teeth clipping	0.0	0.04	0.0	—	0.0	0.02	0.0	—
	Tail docking	0.09		0.0		0.05		0.0	
	Ear notching	0.0		0.0		0.0		0.0	
	Teeth clipping, tail docking, ear notching	0.0		0.09		0.0		0.0	
	No procedure	0.0		0.0		0.0		0.0	
Tail flicking	Teeth clipping	0.08	0.15	0.09	0.07	0.15	0.14	0.0	0.06
	Tail docking	0.29	0.17	0.54		0.41		0.0	
	Ear notching	0.33	0.17	0.18		0.35		0.0	
	Teeth clipping, tail docking, ear notching	0.49	0.17	0.44		0.18		0.0	
	No procedure	0.14	0.17	0.09		0.09		0.0	
Tail jamming	Teeth clipping	0.0	0.11	0.0	0.05	0.0	0.04	0.0	0.02
	Tail docking	0.21		0.18		0.07		0.0	
	Ear notching	0.0		0.0		0.0		0.0	
	Teeth clipping, tail docking, ear notching	0.21		0.24		0.09		0.0	
	No procedure	0.0		0.0		0.0		0.0	
Teeth champing	Teeth clipping	0.92	0.34	0.41	0.1	0.43	0.19	0.0	0.06
	Tail docking	0.29		0.02		0.19		0.0	
	Ear notching	0.21		0.0		0.05		0.0	
	Teeth clipping, tail docking, ear notching	0.77		0.38		0.49		0.0	
	No procedure	0.19		0.14		0.16		0.0	
Head shaking	Teeth clipping	0.0	0.04	0.0	0.03	0.0	0.03	0.0	0.03
	Tail docking	0.0		0.0		0.0		0.0	
	Ear notching	0.07		0.14		0.07		0.0	
	Teeth clipping, tail docking, ear notching	0.07		0.09		0.05		0.0	
	No procedure	0.0		0.03		0.02		0.0	

Sucrose = 1 ml 12% sucrose by mouth; Placebo = 1 ml air by mouth

was significantly different after the procedure from that of piglets that underwent no procedure — that is, were picked up and held only. These behaviours included squealing, head shaking, teeth clamping and tail flicking. Second, the behavioural changes differed significantly in intensity between procedures. In general, if a procedure was performed on a particular part of the body, the behaviours associated with that body part were significantly increased. Third, behavioural changes persisted significantly longer in piglets that had undergone multiple procedures, compared to those undergoing only one procedure. The findings suggest that the management procedures cause significant distress to the piglets.

Blass and Hoffmeyer (1991) found that a sucrose solution was capable of modifying the behaviour of newborn human infants undergoing circumcision or blood collection via heel lance. Healthy, full-term infants who received an oral dose of sucrose prior to these

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procedures cried significantly less than those who received an oral dose of water. Sucrose was shown to affect behaviour for up to 5 min after administration (Blass & Hoffmeyer 1991) and was subsequently recommended for minor surgical procedures as a rapid-acting, non-invasive analgesic.

Sucrose was also shown to modify behaviour in neonatal rats. In a study of infant rats, Blass *et al* (1987) subjected rats to contact with a heated plate to determine paw-lift latency. Sucrose markedly increased paw-lift latency in comparison to rats receiving either water or no substance. The effect of sucrose in rats was also rapid, and was evident immediately after the administration period. The maximal effect was seen 1–3 min after administration, and was minimal by 5 min. Reversal of the effect, through injection of the rats with the opioid antagonist naltrexone, suggested that sucrose stimulated the release of endogenous opioids, which modulated behaviour in response to a painful stimuli (Kehoe & Blass 1986).

In contrast, in our study of piglets, oral administration of a 12% sucrose solution did not decrease the behavioural responses to routine management procedures such as tail docking. One explanation for the apparent lack of effect of sucrose is that the degree of pain in the piglets was greater than that experienced by the human infants and the rats. In rats and human infants, the procedure mainly involved the skin. In the piglets in our study, deeper tissues including nerves, muscle, bone and cartilage were also involved. In addition, skin incision with a scalpel, as occurs in circumcision, would be expected to be less painful than using side-cutters to cut and crush tissue. Therefore, the sucrose solution used may not have been a sufficiently potent analgesic to relieve this degree of pain or to modify behaviour. Further studies are indicated using more potent analgesic agents such as narcotics. Per-cutaneous delivery of the narcotic using a skin patch (eg Fentanyl patch, Janssen-Cilag Pty Ltd, North Ryde, Australia) would avoid the distress of administration by injection and may be more humane.

Another explanation for the apparent lack of effect of sucrose is that both the piglets receiving the sucrose solution and those receiving the placebo had a syringe placed in the mouth. This may have stimulated a sucking reflex that activated endogenous opioid pathways in both groups, thus blurring the effect of the analgesia induced by sucrose. However, piglets in the placebo group that underwent the routine management procedures showed significantly increased behavioural responses such as squealing, head shaking, tail jamming and teeth champing than piglets that underwent no procedure. This suggested that the syringe in the mouth did not significantly modify the behaviour occurring in response to these procedures.

A third explanation is that the time between administration of the sucrose solution and the management procedure was too short for the sucrose solution to adequately modify behaviour. The time used was based on the report in rats that an effect was present immediately after administration (Blass *et al* 1987). In humans, the procedure was also performed immediately after the sucrose solution was administered. However, in both of these studies the sucrose solution was administered over a longer period than in our study. In humans it was delivered slowly by syringe over a 2 min period, or a pacifier was sucked for 2 min (Blass & Watt 1999). Because of the simplicity and low cost of sucrose administration, a further study in piglets is warranted using a longer time interval between sucrose administration and performance of the procedure. Further studies should also examine the influence on weight gain of analgesics or other agents shown to decrease behavioural responses to routine management procedures.

In our study, we did not measure endogenous opioids. To do so would have required taking blood samples, which would have caused additional distress and which may therefore have confounded the results. Initial attempts were made to record the heart rates of piglets using a

portable ECG machine. However, the electrodes were difficult to attach to the skin of the piglets, and the piglets became agitated by the electrodes and wires.

Conclusions and animal welfare implications

In conclusion, a 12% oral sucrose solution administered orally 1 min prior to surgery does not appear to be sufficiently potent to relieve the distress of newborn piglets undergoing tail docking, teeth clipping or ear notching. Although tail docking of piglets is banned in some countries, the procedure continues to be practiced in many other countries. As caretakers of animals, it is our responsibility to ensure that these procedures are performed as humanely as possible. Consequently, further investigation must be carried out to develop simple, easily implemented methods to diminish distress in piglets undergoing these management procedures.

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