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Breastfeeding Is Analgesic in Healthy Newborns

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ABSTRACT. *Context.* **This study identifies a behavioral and nonpharmacologic means of preventing newborn pain.**

Objective. **To determine whether breastfeeding is analgesic in newborn infants undergoing heel lance—a routine, painful, hospital procedure.**

Design. **A prospective, randomized, controlled trial.**

Setting. **Hospital maternity services at Boston Medical Center, Boston, Massachusetts, and Beverly Hospital, Beverly, Massachusetts.**

Participants. **A random sample of 30 full-term, breastfed infants.**

Interventions. **Infants in the intervention group were held and breastfed by their mothers during heel lance and blood collection procedures for the Newborn Screening Program Blood Test. Infants in the control group experienced the same blood test while receiving the standard hospital care of being swaddled in their bassinets.**

Outcome Measures. **Crying, grimacing, and heart rate differences were analyzed between the breastfeeding and the control infants before, during, and after blood collection.**

Results. **Crying and grimacing were reduced by 91% and 84%, respectively, from control infant levels during the blood collection. Heart rate was also substantially reduced by breastfeeding.**

Conclusions. **Breastfeeding is a potent analgesic intervention in newborns during a standard blood collection.** ***Pediatrics*** **2002;109:590–593;** ***breastfeeding, skin-to-skin contact, crying, grimacing, heart rate, heel lance, human newborns, pain.***

ABBREVIATIONS. bpm, beats per minute; SD, standard deviation.

Breastfeeding links evolutionary biology and medical practice. This is of clinical interest because pain is routinely experienced in hospital settings, even by healthy newborns, and natural interventions are effective at a time when many pharmacologic interventions are not.[1] Premature and sick infants often experience multiple painful diagnostic and therapeutic procedures for which the long-term consequences are not known.[2] Single, intense, painful experiences such as circumcision remain manifest for at least months in the form of exaggerated reactivity to routine immunizations.[3,4] In animal models, intermittent pain can permanently affect limbic catecholamine levels and reactions to situational or pharmacologic stressors.[5] The claim can no longer be made that newborn pain is for the moment only.

Recent studies have demonstrated that certain tastes and flavors alleviate newborn pain. As little as 2 mL of milk,[6,7] its fat,[6] protein[6] components, or sweet substances[8–25] all reduce pain in human and rat infants and eliminate spontaneous crying as well. Moreover, in rats the mechanisms underlying these taste-induced analgesics are opioid-mediated[26–28] and block pain afferents at the level of the spinal cord.[29]

Nonnutritive suckling itself is also "antinociceptive" in rat and human infants,[8,30] and suckling experience is not required for its manifestation.[31] Contact alone, in the absence of suckling, also dulls pain reactivity. Specifically, crying and grimacing are markedly reduced during blood collection in newborns held by their mothers in full-body contact. Such contact also blocks the substantial increase in heart rate that normally accompanies blood collection.[32] Although the mechanisms underlying tactile-induced "antinociception" have not been identified, they do not seem to be opioid-mediated.[33]

The purpose of this study was to unite the different components of nursing (taste, suckling, and skin-to-skin contact), which have been shown to be individually analgesic, by allowing newborns to suckle their nursing mothers before, during, and after a standard heel lance procedure for blood collection. The efficacy of this intervention was determined by evaluating video recordings of infant crying and facial expressions and by assessing blockade of heart rate increases that normally accompany the blood collection procedure.

METHODS

Participants

The study participants were 30 healthy, full-term, breastfed newborns delivered at Boston Medical Center, Boston, Massachusetts, and Beverly Hospital, Beverly, Massachusetts, between January and November 1999. After mothers had given written, informed consent, their infants were randomly assigned to 1 of 2 study groups using a system of sealed envelopes. Thirty envelopes, 15 breastfeeding and 15 control, each designating group assignment, were mixed and shuffled. After informed consent was obtained, the top envelope from the stack was opened identifying the group assignment. In the intervention group ($N = 15$), infants were breastfed during blood collection. Control infants ($N = 15$) were swaddled in their bassinets during the procedure (standard hospital treatment). One infant failed to complete the study because of difficulties with latching at the breast. This infant's group

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assignment was resealed in an envelope and reshuffled with the remaining envelopes. The 2 groups were demographically equal as determined by 2-tailed Fisher exact tests or Student *t* tests (Table 1).

All infants had been delivered by normal, spontaneous, vaginal delivery, and no infant had presented any evidence of congenital abnormalities, medical complications, or drug exposure. No infant had required either oxygen administration or ventilatory support. Infants had been fed between 30 minutes and 4 hours before the start of the study. The average time between last feed and the heel lance procedure was 198 minutes for the breastfeeding group and 197.5 minutes for the control group. The difference between these 2 groups did not differ by a *t* test comparison ($P > .05$). This was the initial heel lance for all infants, and no infant had been circumcised before the procedure.

Based on our previous study,[32] in which skin-to-skin contact provided antinociception during heel lance, we calculated that a sample size of 15 infants per group was necessary to achieve a statistically reliable reduction in grimacing and crying, with a power of 80% and a *P* value $< .05$. The institutional review boards of the Boston Medical Center, Boston University School of Medicine, University of Massachusetts at Amherst, and Beverly Hospital approved the protocol governing these studies. Seventy-eight percent of the mothers approached for participation gave their consent.

Data Collection

All infants were prepared for the study by placing 3 safety electrodes (Klear Trace 2000-S; CAS Medical Systems, Branford, CT) on their thoracic region and a warming pad on 1 heel. Control infants were then wrapped in their receiving blankets and placed on their side in their crib. Infants in the breastfeeding group, wearing only a diaper, were returned to their mothers to initiate breastfeeding. Mothers were reclined and cradled their infants during breastfeeding to maintain full-body, skin-to-skin contact during the entire procedure. The study was timed to coincide with the next feed. A lactation consultant (L.W.M.) assisted with positioning and assessment of suckling. The study was initiated when the infant maintained a good latch as determined by a large amount of areola in the mouth, flanged lips, and active jaw movement. This generally required 30 to 60 seconds to achieve. Once this was achieved, infant and mother were covered with 2 receiving blankets in a manner that left the infant's face visible for filming from the side of the bed. The mother's face did not appear on film.

The study proper began with filming (Sony Model CCD-TRV32, New York, NY) the infant's face during breastfeeding or during rest (control infants). Heart rates were announced every 10 seconds from the monitor. After the 2-minute baseline period, the heel warmer was removed, and the heel was swabbed with alcohol. Then, to reduce procedural variability, 1 physician (L.G.) used a spring-loaded lancing device (Tenderfoot, International Technidyne Corporation, Edison, NJ) to draw blood for the Newborn Screening Program Blood Test. After blood collection was completed, a Band-Aid (Johnson & Johnson Consumer Products Company, New Brunswick, NJ) was applied to the heel. This initiated the recovery phase of the study, which lasted an additional 2 minutes. The entire study lasted about 7 to 8 minutes.

Because L.G. conducted all heel lances, a potential bias of differential treatment has been introduced. Having only 1 person conduct the procedure markedly reduces experimenter variability. We are not concerned about bias because procedure duration between experimental and control groups did not differ (*t* test comparison; $P = .8298$). Moreover, heel lance procedure time duration and amount of cry in the present study are highly comparable with infants in our earlier studies,[8,32] thereby making it less likely that experimenter bias determined present group differences.

TABLE 1. Characteristics of Study Groups

Characteristic	Experimental ($n = 15$)	Control ($n = 15$)	*P* Value
Mean estimated gestational age	39.8	39.9	.13
Number of females	8	9	.7
Mean birth weight	3480	3524	.78
Mean study weight	3327	3343	.91
Mean Apgar at 1 min	9	8	.20
Mean Apgar at 5 min	9	9	.33
Ethnicity of mother	4 Black 9 White 1 Hispanic 1 Other	1 Black 11 White 3 Hispanic 0 Other	.23
Mean postnatal age (h)	46	40	.11
Mean maternal age (y)	30	28	.46
Mean number breastfeeds before	13	10	.13
Mean number bottlefeeds before	0	1	.54

Outcome Measures

Videotapes were scored by research assistants, who were neither informed of study design nor aware of the number of study groups. Facial grimacing was scored continuously from the video portion of the tape, and crying and heart rate was scored from the audio portion with video blank, thereby resulting in scorers who were uninformed about which group an infant belonged to during heart rate and crying scoring. Crying was scored continuously as the presence of an audible crying sound independent of quality. Facial grimacing was scored when brow bulging, eye squeezing, and nasolabial folding occurred simultaneously; the 3 measures determined most sensitive for pain by the studies of Grunau and Craig.[34–36] Very occasionally, the breast partially obscured the infant's face. In these instances, 2 of the 3 pain markers were required to be present to score a facial grimace. Heart rate was scored in 10-second intervals from the audio portions of the videotape. Because the changes in heart rate are large and sustained, we feel justified in using the current index. The heart rate was continuously monitored, and in our experience once the circa 25 beat per minute (bpm) heart rate increase had occurred, there is little moment-to-moment heart rate variability. Finally, intercoder reliability was 95% for all measures.

Statistical Evaluations

Simple *t* tests were performed on the mean percent cry and grimace measures during blood collection. Heart rate changes for the 2 groups were assessed through a 2-factor analysis of variance with repeated measures across the 3 phases of the experiment (baseline, blood collection, and recovery intervals). All analyses used SAS software (SAS Institute Inc, Cary, NC).

RESULTS

The outcome of this study is clear: breastfeeding during blood collection essentially eliminated crying and grimacing. Breastfeeding also prevented the marked rise in heart rate that normally accompanies heel lance.

Breastfeeding infants cried for only 4% ($P = .0002$; standard deviation [SD]: 7.23%; mean duration: 8.77 seconds) and grimaced for 8% ($P = .0001$; SD: 12.18%; mean duration: 17.25 seconds) of the entire blood collection procedure compared with 43% crying (SD: 30.83%; mean duration: 72.07 seconds) and 50% grimacing (SD: 26.69%; mean duration: 80.31 seconds) in control infants (Fig 1). In fact, 11 of these 15 breastfeeding infants did not cry or grimace at all during this otherwise painful experience. These effects extended well into the recovery phase. Only 1 of the 15 infants in the breastfeeding group cried at all during recovery. He did so for a total of 10 seconds. In contrast, the mean duration of crying during recovery for infants in the control group was 28 seconds.

Breastfeeding also prevented the tachycardia induced by blood collection (Fig 2). Overall, a significant interaction between group and procedure time

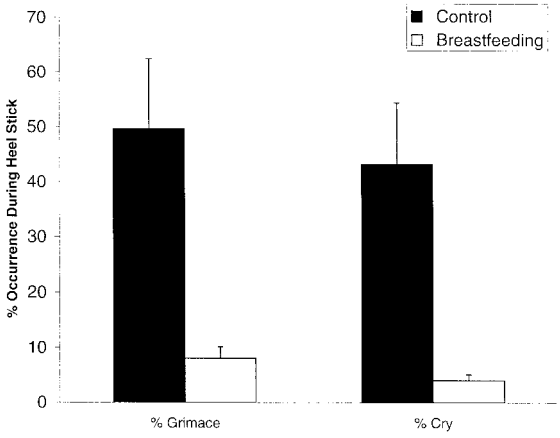

Fig 1. Mean (+ SEM) percentage occurrence of grimacing and crying during the heel stick procedure for control newborns and newborns who were breastfeeding before and during the procedure (N = 15/group).

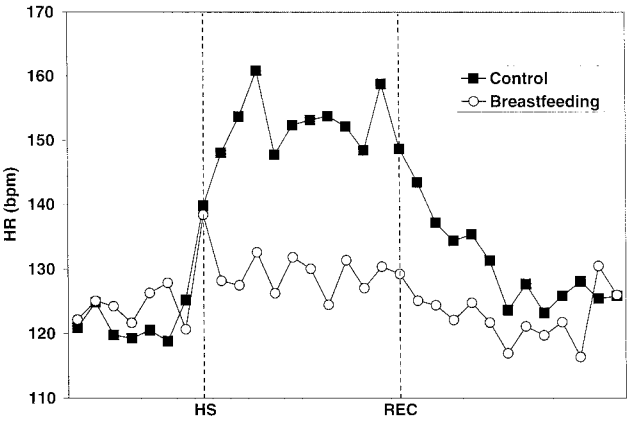

Fig 2. Mean heart rate (bpm) at 10-second intervals for the entire study of control and breastfeeding infants.

was observed (P = .001) indicating that the change in mean heart rate across the precollection, collection, and recovery intervals differed between breastfed and control infants during and after heel lance. In particular, mean increase in heart rate between baseline and blood collection phases for control infants was 29 bpm, whereas that for nursing infants was only 6 bpm.

DISCUSSION

Breastfeeding before, during, and after a painful blood collection procedure markedly suppressed crying and grimacing and prevented the increase in heart rate that normally accompanies this procedure. Indeed, 11 of the 15 breastfeeding infants did not cry or grimace at all during the procedure. When watching these infants on videotape, we could not tell when blood collection was either initiated or terminated. We believe that this reflects pain blockade, as opposed to suckling producing a behavior that is incompatible with crying. Infants could detach from the nipple, and some did. In any event, suckling certainly does not interfere with expressions in facial countenance that convey pain perception.

The nursing-induced analgesia documented herein and its component parts of taste-, suckling-, and contact-induced analgesias are all available to newborns at term and probably before, judged by the widespread success of sucrose-induced analgesia in premature infants. The present data do not allow us to evaluate which component of the suckling act contributed most to the analgesia, nor do they allow assessment of interaction among components. The most available comparison is with the contact-induced analgesia. Skin-to-skin contact was effective in reducing the pain experienced during heel lance. Eight of 15 infants held by their mothers during the procedure did not cry at all, and their crying was reduced 83% compared with their controls. Three infants in skin-to-skin contact did not grimace at all during the heel lance, and grimacing was reduced 65% compared with their controls.[32] Breastfeeding caused 11 of 15 infants not cry at all during the heel lance procedure (9 of 15 did not even grimace) and reduced mean cry levels by 90% and grimacing by 84% compared with their controls. Although formal statistical comparisons are precluded across studies, we believe it is unlikely that the analgesic effect of breastfeeding can be exclusively attributed to skin-to-skin contact because of the somewhat greater amount of grimacing seen in the skin-to-skin procedure. Moreover, our clinical experience with these 2 interventions leads us to favor breastfeeding. Simply holding the infant while preventing access to the breast frustrated the mother and infant. Uniformly, a period of time—as much as 15 minutes for some—was required for the 2 to relax and settle down. In contrast, infants immediately initiated breastfeeding and the heel lance began within seconds after the infant had established a good suck.

The extensive parallel findings between rat and human infants suggest that the components of these analgesias are both phylogenetically conserved and robust. Ren et al[29] have demonstrated that analgesia in suckling rats that received sucrose, reflected blockade of spinal afferents at the level of the dorsal horn. Parallel findings between the species in behaviorally induced analgesias, and the lack of any indication of discomfort in 11 of the suckling infants, makes the dorsal horn a reasonable point of impact in the present study as well. (See also Taddio[3] on this point).

A comment on our control group is necessary. The use of a "standard hospital treatment" control group is simultaneously a strength and limitation of this study. The ability to compare the analgesic properties of breastfeeding with standard care reveals breastfeeding's robust effect. This behaviorally induced analgesia and the similarly effective procedure of skin-to-skin contact[32] and orosensory stimulation[6–22] for alleviating pain during routine heel lance add to the growing scientific literature and international consensus[37] of the necessity to provide appropriate analgesia for newborn pain. As such, the continued use of "no treatment" controls is becoming ethically difficult to defend with numerous safe and effective pain-relieving options available. Indeed, our own institution Boston Medical Center in reflecting the progress of our discipline now requires that parents be offered safe, natural, ways to combat

newborn pain. These options include breastfeeding and tasting sucrose for routine painful procedures.

Finally, the present findings must be placed in a context broader than relieving immediate newborn pain or stress. The rapidly expanding literature about the subtle stresses experienced by animal and human newborns convincingly demonstrates that even mild stress during this early period can cause permanent changes in limbic catecholamine neurotransmission and exaggerated behavioral and endocrinologic reactivity to mild adult stress. The American Academy of Pediatrics promotes breastfeeding for proven "health, nutritional, immunologic, developmental, psychological, social, economic and environmental benefits."[38] The present findings now add the benefits of analgesia and stress reduction. It would seem prudent to exploit evolutionary-conserved systems in the medical management of stress and pain during early infancy, the time when many otherwise potent pharmacological interventions are not appropriate.[1]

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