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The effects of breast milk odor on the physiological and behavioral responses caused by venipuncture pain in term infants: A clinical trial study

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Abstract:

BACKGROUND: Pain management is very important for infants who are unable to express it verbally. Pain control is one of the nursing actions and part of their duties. This study attempted to determine the effects of breast milk odor on the physiological and behavioral responses caused by venipuncture pain in full-term infants at an educational hospital.

MATERIALS AND METHODS: This randomized clinical trial study was carried out on 3–5 days' term and healthy babies with a gestational age of 34 weeks and later in the 9-Day Hospital of Torbet Heydariyeh, Iran, 2021. The sample size, taking into account the possibility of a 10% dropout of samples included 20 babies for each group and a total of 40 babies were selected by convenience sampling. To collect data, a checklist of demographic characteristics, a registration form for physiological responses, and the modified behavioral pain scale were used.

RESULTS: The results of this study showed that breast milk odor has a positive effect on behavioral responses ($P < 0.001$) and also a significant relationship was observed between the effects of breast milk odor and physiological responses percentage of oxygen uptake and pulse ($P < 0.001$). However, no significant relationship was observed between breast milk odor and breathing variables ($P > 0.05$).

CONCLUSIONS: According to the results, olfactory stimulation with breast milk during venous blood sampling showed positive effects on physiological responses and pain reduction in infants. Therefore, it is recommended to use soothing stimuli such as the smell of breast milk during painful procedures in babies.

Keywords:

Behavior, breast milk, pain, term birth

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Introduction

The word pain is derived from the Greek word Pain, which means retribution and punishment, and is an unpleasant sensory experience that reaches the brain through sensory neurons, and these uncomfortable signals are caused by potential or actual damage in the human body.[1,2] Recognizing pain, as one of the most common causes of health disturbances, can be one of the goals of health care providers.[3,4] Neurological studies have shown that pain affects neural development and affects subsequent responses to painful stimuli and behavioral responses. Therefore, performing painful procedures such as taking blood and taking blood samples from infants can cause significant psychological damage to them.[5] Painful and stressful movements cause an increase in catecholamine, an increase in heart rate, an increase in blood pressure, and an increase in the pressure inside the brain. Moreover, decrease in

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blood oxygen, decrease in heart rate, acidosis, increase in blood glucose level and irregular breathing, and pneumothorax are other pathological conditions caused by the infant's responses to pain.[6] Furthermore, studies have shown that the hormones released due to untreated pain may aggravate the injury and prevent the healing of the wound, thus increasing the chance of infection as well as the length of hospitalization and the chance of death.[7] Therefore, trying to reduce the amount of pain and stress inflicted on the baby can prevent a lot of future injuries.[3]

In the past, it was widely believed that babies do not feel pain. For this reason, pain relief was not considered. But recent research has proven that the sensitivity of term babies to pain is the same as that of infants and children, and premature babies may be more sensitive to pain and its harmful effects.[8,9] Since babies are not able to express their pain verbally, their response to painful stimuli should be expressed in visible and measurable behavioral and physiological reactions such as changing facial expressions (raising eyebrows, squeezing eyes, creating folds in the face above the lips and...) and changes in physiological indicators (increased heart rate and decreased percentage of arterial oxygen saturation). Since painful actions create a stress response for the baby,[10] pain control plays a very important role in preventing its unwanted physical and psychological effects.[11] So that the American Pain Association has called it the fifth vital sign to emphasize its importance and increase the awareness of health team members in its control.[4]

Medicinal and non-medicinal measures are part of pain control methods in infants.[12] In infants, to reduce the effects of pain, drug treatment is rarely used during painful procedures, because central painkillers cause harmful side effects such as rash, hives, and skin redness for the baby. Therefore, it is very important to pay attention to non-pharmacological methods effective in reducing infant pain.[13] The use of non-drug methods for mild to moderate pain can be applied by nurses and does not require a doctor's prescription. Among the non-pharmacological methods of pain control in infants, we can mention olfactory stimulation, hugging, distraction, non-nutritive sucking, shaking the baby, feeding with breast milk, skin-to-skin contact, and swaddling.[14,15]

The sense of smell is one of the most developed human senses at birth, which guides the baby to the source of nutrition. In this regard, breast milk odor is particularly important because it creates an emotional connection with the baby and affects his behavior and feelings throughout his life.[16,17] Babies recognize the smell of milk and their mother's body in the very first days of birth.[18] They also prefer the smell of their mother's amniotic fluid over other mothers.[19] This early olfactory preference and its importance for survival have led to the question of whether maternal odors may have calming effects in infants. Several studies have shown a reduction in persistent crying in infants when they were exposed to amniotic odors.[20]

It is possible for a human baby to recognize the milk odor in the first days of birth, without having consumed the milk. In a study conducted on the effects of the milk odor on preterm babies, it was found that the milk odor has a calming effect on them and their pain score was lower compared to the group exposed to the odor of formula.[21] Today, babies are exposed to numerous and unavoidable painful procedures after birth. One of the painful and invasive processes that every infant faces at the beginning of birth is taking blood from the heel.[4] Considering that learning and memorizing pain occurs with the first painful experience and will have profound effects on subsequent painful experiences and infant's responses[21] and considering that a healthy infant is exposed to procedures in the first few days after birth; there are many painful conditions, pain control is necessary to moderate its destructive effects. Since non-pharmacological methods of pain control pain with different mechanisms and cover a wide range of treatments, it is necessary to choose the methods that have the greatest effects in reducing pain in infants. This study was conducted with the aim of determining the effects of breast milk odor on the physiological and behavioral responses caused by venipuncture pain in term infants at 9-Day Hospital.

Materials and Methods

Study design and setting

This randomized clinical trial study was carried out on 3–5 days' term and healthy babies with a gestational age of 34 weeks and later in the 9-Day Hospital of Torbet Heydariyeh, Iran, 2021. The sample size, included 20 babies for each group and a total of 40 babies were selected by convenience sampling.

Inclusion criteria were the weight of 2,500 to 3,500 grams, Apgar score greater than 8, absence of abnormalities and congenital diseases such as cleft palate, not receiving sleeping medication 48 hours before sampling from the vein, another painful procedure before the intervention, nutrition less than 1 hour before the intervention and full consciousness.

Exclusion criteria included the occurrence of any respiratory and digestive problems during the intervention or the parents' refusal to continue participating in the research.

Data collection tool and technique

To collect samples, after the approval of the ethics committee of the university and obtaining permission from the authorities of the hospital, the researcher visited the hospital daily and gave the necessary explanations about the purpose of the research and the procedure to the parents of infants who met the criteria. After entering the study, a sample of baby's venous blood was taken, and a written consent form was given to the parents. Sampling was done on the spot and they were randomly assigned into two groups.

To collect data, a checklist of demographic characteristics was used, which included the sex of the baby and the type of delivery of the mother (Cesarean–natural). To determine behavioral pain responses following vaccination, the modified behavioral pain scale (MBPS) was used. This scale was prepared by Taddio *et al*.[22] and scores three behavioral parameters in the baby. The first parameter is the facial expression which includes four situations. The first state is clearly positive (smiling) with a score of 0, the second state is neutral (no smile or a clear frown) (score 1), the third state is mildly negative (frowning) (score 2), and the fourth state is clearly negative with furrowed eyebrows and completely closed eyes (score 3).

The second parameter, crying includes five modes. The first state, laughing or smiling (score 0), the second state, not crying (score 1), the third state, quiet moaning, producing the sound of crying or moaning (score 2), the fourth state, crying or continuous crying (score 3), and the fifth state is crying more than the first crying of the baby (when the baby cries from the beginning) (score 4).

The third parameter scores the baby's movements and includes six modes. The first state is normal movements and activity (score 0), the second state is lying down and relaxed (score 1), the third state is relative movements such as folding the limbs and twisting (score 2), the fourth state is trying to avoid pain by pulling back the part that is needled (score 3), the fifth state is restlessness with general movements including shaking the head or limbs (score 4), and the sixth state is stiffening of the body (score 5).

After assigning a score to each of the modes, the scores are finally added together and a total score is obtained from the behavioral responses, the lowest score being zero and the highest score being ten. This tool has been used many times in various researches and its validity and reliability have been confirmed.[22,23] Among them, the validity and reliability of the MBPS tool were confirmed in Taddio *et al*.'s study with Cronbach's alpha of 0.86.[24] In Iran, in the study of Taavoni *et al*., the correlation method between observers was used for the reliability of the instrument, and the Pearson correlation coefficient was 0.862.[23]

In order to check the validity of the instrument, the content validity method was used; in this way, the tool was provided to 10 academic staff members of Torbat Heydariyeh University of Medical Sciences, and after collecting opinions, necessary modifications were made and used for research. In order to record the pulse number and arterial oxygen saturation percentage, the pulse oximeter of Rah Salamat was used, which is a standard device. To determine the reliability of the pulse oximeter device, the equivalent reliability method was used; in this way, physiological data such as heart rate and percentage of arterial oxygen saturation by this device were compared with another standard pulse oximetry device called Nelcor and the registered number in both devices was the same. The number of breaths was recorded by the researcher using a wristwatch. Therefore, before starting the study, the researcher closed the pulse oximeter probe on the baby's wrist without applying extra pressure. In the breast milk odor group, a sample of breast milk was used to stimulate the baby's smell, then 2 cc of milk was poured on a napkin and placed at a distance of 3 cm from the baby's nose. This work started 3 minutes before blood sampling from the baby's vein and continued until the completion of the procedure.[25] Heart rate and percentage of arterial oxygen saturation were recorded by pulse oximeter device, immediately before the start of the intervention as the base time and immediately after the intervention, which will be the end of the blood sampling time from the vein.

Ethical consideration

This study was approved by the Ethics Committee of Torbat Heydariyeh University of Medical Sciences with the code (IR.THUMS.REC.1398.050) and obtained the clinical trial code (IRCT20191130045557N1). In addition, written consent was obtained from the participants to conduct the research.

Data analysis

The study data were analyzed by Statistical Package for the Social Sciences version 21 statistical software. The normality of the data was checked using the Smirnov–Kolmogorov test. Frequency, mean, and standard deviation were used to describe the data. Independent t-test to check the difference between the means before and after the intervention between the two groups and paired t-test to check the difference between the means, before and after the intervention in each group were used for data analysis.

Results

This study was conducted on 40 infants who were selected by random sampling. The results showed that

24 (60%) of the babies were girls and 16 (40%) were boys. Twenty-two (55%) of the babies in the breast milk odor group were born naturally and 18 (45%) were born by cesarean, and in the control group, 14 (35%) were born naturally and 26 (65%) by cesarean [Table 1].

The average scores of behavioral responses after venous blood sampling in the breast milk odor group compared to the control group had a statistically significant difference ($P = 0.001$) and indicated the positive effects of olfactory stimulation with breast milk in the present study on the behavioral responses of pain in infants during blood sampling. The vein and discount of these responses are compared to the control group [Table 2].

According to the results of the paired t-test, the average percentage of blood oxygen saturation in the breast milk odor group had a significant difference after the intervention compared to before ($P = 0.001$), but this difference was not significant in the control group ($P > 0.05$). These results showed that olfactory stimulation with breast milk has been able to significantly prevent the reduction of blood oxygen saturation percentage as a physiological index of pain [Table 3]. The results of Table 3 showed that there was a significant difference between the breast milk odor group before the intervention and after the intervention in terms of the average number of pulses per minute ($P = 0.05$). This means that the increase in the number of pulses per minute in the breast milk odor group was less after the intervention. The results of Table 3 also showed that in both groups the breathing rate increased after venous blood sampling, but this increase was the same in both groups and there was no significant difference between the groups [Table 3].

Table 1: Frequency distribution table of gender and type of delivery in two groups of breast milk smell and control

Variable		The smell of breast milk, *n* (%)	Control, *n* (%)
Gender	Girl	12 (60%)	10 (50%)
	Boy	8 (40%)	10 (50%)
Type of delivery	Vaginal	11 (55%)	7 (35%)
	Cesarean	9 (45%)	13 (65%)
Total		20 (100%)	20 (100%)

Table 2: Comparison of average scores of behavioral responses in two groups after the intervention

Groups	Mean±SD	Two-sample *t*-test
The smell of breast milk	5.30±1.38	0.001
Control	6.95±1.46	

Table 3: Comparison of the average percentage of blood oxygen saturation, breathing rate, and pulse in two groups before and after the intervention

variable	Intervention	The smell of breast milk, Mean±SD	Control, Mean±SD
Oxygen saturation percentage	Before	88.45±10.57	92.60±3.18
	After	93.50±3.76	92.75±2.80
t-test		<0.0001	0.89
Breathing rate	Before	40.15±8.76	45.10±11.51
	After	41.80±10.27	45.45±11.10
t-test		0.53	0.93
pulse	Before	130.65±8.02	150.60±9.61
	After	125.95±7.74	126.00±6.94
t-test		0.05	<0.0001

Discussion

This study was conducted with the aim of investigating the effects of breast milk odor on the physiological and behavioral responses caused by venipuncture pain in term infants. The results related to comparing the behavioral and physiological responses caused by venous injection in the two investigated groups showed that the average scores of behavioral responses after venous blood sampling in the test group compared to the control group had a statistically significant difference and the average behavioral response scores in this group were lower than the control group. In the comparison of the two groups, it was found that in the experimental group, the average behavioral responses were lower than the control group and that there was a significant difference between the two experimental groups and the control group in terms of the score of behavioral responses, indicating the positive effects of olfactory stimulation with milk. Maroufi *et al*., which examined the effects of olfactory stimulation with breast milk and the smell of vanilla (as a smell that was already introduced to infants) on the behavioral states of infants during blood sampling, showed that the level of restlessness and crying of infants' subject to olfactory stimulation was significantly less than the control group.[18] In Nishitani *et al*.'s study, olfactory stimulation with breast milk significantly reduced the crying time of infants during heel blood sampling compared to the control group.[20] Moreover, in Varendi's research, stimulating the smell of babies after birth with amniotic fluid, as the smell that babies are familiar with before birth, significantly reduced their crying and restlessness behavioral responses after birth.[26]

These results were consistent with the results of the present study in the experimental group in terms of behavioral responses to pain. Based on the research conducted in this field, olfactory stimuli can be effective background keys for retrieving memories.[12] Therefore, it seems that in the present study, olfactory stimulation with breast milk was able to restore the memory related to the comfort that comes from the mother to the baby, thus reducing the behavioral reactions caused by pain.

As in the researches, olfactory stimulation with familiar odors has a calming effect on behavioral responses. In the present study, the average percentage of oxygen saturation of arterial blood increased in both groups after the intervention compared to before. According to the results of the test, the average percentage of blood oxygen saturation in the test group had a significant difference after the intervention compared to before, but this difference was not significant in the control group.

These results showed that olfactory stimulation with breast milk in the experimental group was able to prevent a significant decrease in blood oxygen saturation as a physiological indicator of pain, and since physiological and behavioral responses are influenced by each other, the consistent results in both types of responses of physiological and behavioral in the experimental group seem reasonable. In Mahmud *et al*.'s study of preterm babies, it was found that the pain score of babies who were stimulated with breast milk odor was significantly lower than the group that was stimulated with the smell of formula, which was consistent with the results of the present study and this can be related to restoring the memory of the mother for the baby and the calming effect caused by the feeling of the mother being next to the baby.[13]

The results revealed that there was a significant difference between the breast milk odor group before the intervention and after the intervention in terms of the average number of pulses per minute. This means that the increase in the number of pulses per minute in the experimental group after the intervention was less. The results of Table 3 showed that in both groups, the breathing rate increased after venous blood sampling, but this increase was the same in both groups and there was no significant difference between the groups, which was not similar to other findings of this research in the field of behavioral responses, percentage of arterial oxygen saturation and pulse. Since besides the definite signs of pain in newborns (increased heart rate and decrease in arterial oxygen saturation percentage), increased breathing rate was also considered as a sign of pain in newborns, so it can be said that perhaps one of the causes of this discrepancy was related to the time of registration of the number of breaths as one of the principles of counting the number of breaths in a baby is to count it when it is calm and without crying.

In the current study, the breathing rate of the babies before the intervention was measured in calm conditions and for all the babies in almost the same conditions, and the non-significance of the breathing rate before the intervention seems logical, but the counting of the breathing rate was related to after the completion of blood sampling and that in almost all babies, crying due to pain prevented the correct measurement of the number of breaths per minute. The major limitations of this research were the impossibility of controlling all the factors involved in the intervention, such as equalizing the conditions of the babies a few hours before the intervention and the small number of samples.

The impossibility of controlling all the factors involved in the intervention, such as equalizing the conditions of the babies a few hours before the intervention, was one of the limitations of the present study. Therefore, it is recommended to carry out more studies and control the condition of babies as much as possible before intervention. It is also suggested that in future researches, the scores of behavioral responses in different parts of this scale should be checked separately to obtain more accurate results of the effect of this method on various aspects of behavioral responses.

Conclusion

The results of this study showed that the use of breast milk odor during venous blood collection reduces the pain of babies, and it is more effective in relieving the pain faster after the blood collection is completed. Therefore, it is suggested that due to the inevitability of babies facing many painful procedures during infancy, medical workers in newborn care departments and health centers can use effective non-pharmacological methods such as olfactory stimulation with breast milk to take an effective step in reducing the symptoms of pain in babies.

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Conflicts of interest

There are no conflicts of interest.

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