J Pediatr Res 2023;10(1):43-54
DOI: 10.4274/jpr.galenos.2022.67799

Original Article

Effects of White Noise and Facilitated Tucking During Heel Stick Sampling on the Pain Response of Healthy Term Newborns: A Randomized Controlled Study

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ABSTRACT

Aim: Painful procedures in the newborn begin with injections. Controlling painful practices in the newborn is of great importance. Nurses should be familiar with evidence-based non-pharmacological methods to reduce pain. This study was performed to compare the effect of white noise, facilitated tucking, and their concerted application during heel-stick sampling on pain in term babies.

Materials and Methods: A randomized controlled trial was conducted. The study was conducted on 90 newborns. Using stratification and the blocking method, 30 newborns were included in the white noise group (Group 1), 30 in the facilitated tucking group (Group 2), and 30 in the white noise + facilitated tucking group (Group 3). Pain scores of the newborns in all groups before, during, and after the procedure were evaluated by two nurses independent of each other using the neonatal infant pain scale (NIPS).

Results: When the NIPS scores of the neonates during the heel-stick sampling procedure were compared, a significant difference was detected between the groups ($p<0.001$).

Conclusion: The pain score of the group that was made to listen to white noise and had been placed in the facilitated tucking position during the application was significantly lower than in the other two groups.

Keywords: Facilitated tucking, newborn, pain, white noise

Introduction

The International Association for the Study of Pain defines pain as “an unpleasant sensory and emotional experience associated with or resembling actual or potential tissue damage” (1). Pain begins to be felt in intrauterine life when the fetus is in the 20-24th gestational week. It has in fact been determined that the fetus can respond to pain from the first week of life (2). Metabolic, hormonal, cardiorespiratory and behavioral changes occur in response to pain. The most important problem encountered when assessing pain in the newborn is the infant’s inability to verbalize the pain response. Particular attention should be paid to nonverbal physiological and behavioral signs when measuring pain in infants (3). Painful procedures can negatively affect a newborn’s adjustment to the external world (4). Starting from the first moments of life, it is the primary responsibility of the nurse to prevent the pain babies feel during painful procedures, and to help them cope with this pain (5). Other than the application of analgesics to reduce pain, nurses can also make use of

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Received: 11.10.2022 **Accepted:** 19.12.2022

non-pharmacological treatment methods. There are many non-pharmacological methods to reduce or eliminate the pain felt during interventional procedures. Among these methods are breastfeeding (6-7), the scent of mother's milk (8), the use of oral sucrose (9-11), skin-to-skin contact (3), kangaroo mother care (12,13), massage (14), and music (15). Another two effective methods are facilitated tucking (16-20) and white noise (21-24).

Sensitivity to touch develops in the 8th gestational week and by the 32nd gestational week, most of the baby's body becomes sensitive to even the light stroke of a feather (25). Sensitivity continues to grow significantly after birth. The primary method of communication for a newborn is, in fact, tactile contact. Gently touching a newborn can calm the baby and positioning the baby in the fetal position is conducive to both pacifying the infant through tactile stimuli and to allowing the baby to take the physiological position that will bring about the best protection (26). This method is therefore quite advantageous for these reasons. Facilitated tucking is the practice of holding the baby's arms and legs in a flexed position close to the midline of the torso, allowing the baby to move the extremities. Facilitated tucking may be used before invasive procedures, such as the heel-stick, to alleviate distress (5). The facilitated tucking position is one of the methods that involves touching and positioning the baby (27). Facilitated tucking aids the infant's ability to use the skills of self-regulation, such as bringing hands to mouth, grasping, or holding, so as to better cope with minor pain and stress (16,17,19,20,24,28). In Spain, facilitated tucking is a routine procedure for healthy neonates who were born in a hospital and are accompanied by their mothers during blood sampling (19).

Music is a very effective stimulant in relieving newborn pain. Audible alarms effectively distract the baby's attention, providing a cognitive strategy to control pain and suppress the pain response (29). Since white noise is a continuously monotonous sound in the form of a hum, it resembles the sounds in the mother's womb. Neonates are sensitive to white noise, which has a wide frequency spectrum (23,30,31). It is believed that fetal hearing develops before the 28th week of pregnancy (32). The baby in the intrauterine environment hears the reflected sounds of the mother's heartbeat, the sounds of her gastrointestinal system, the sounds made by the amnionic fluid as it joggles around inside the uterus, as well as sounds that are audible from the outside environment (33). It is known that following birth, rediscovering the abdominal sounds and rhythms of a mother has a relaxing and calming effect on a neonate. Experimenting with musical sounds does not only satisfy a newborn's emotional needs, but also provides feelings of safety and comfort (34). There is evidence in the literature that intrauterine sounds reduce stress, anxiety and pain and have a soothing effect on the fetus/baby and that these sounds positively affect the infant's physiological state (21,23,30,31). The common point in both methods examined is the effort to provide the the baby with the environment of the mother's womb.

There are no comparative studies in the literature that provide data as to which one of the two methods is more effective or about the effect of the combined application of these two methods on pain. Hence, our study was performed to identify the effect of white noise, facilitated tucking, and their combined application during heel-stick sampling on the level of pain in healthy term babies.

Materials and Methods

Study Design

The study was designed as a randomized clinical trial conducted at a single medical center. The design of the randomized experimental research is shown in Figure 1 (35).

Sample and Procedures

The criteria for inclusion in the study were: being a term baby, being with the mother, being a healthy baby who was being fed orally, having been fed at least half an hour before the procedure, not having received analgesics and/or sedatives within the last 24 hours, not having any complications that would prevent pain evaluation (e.g. intracranial hemorrhage, neuromotor growth retardation), not having undergone any painful procedures within the last hour (e.g. blood drawing, aspiration, ophthalmologic examination), having no prior history of surgery, not being connected to mechanical ventilation, and being able to draw the baby's blood on the first try (since the pain level can change on the second try).

The babies who met the study criteria and whose mothers gave informed consent were stratified according to their gestational age and then randomization was performed by casting lots. Three slips of paper of the same quality, size and thickness were marked as "white noise", "facilitated tucking" and "white noise + facilitated tucking," then folded and placed in a cloth bag. A health worker other than the researcher was asked to draw the slips and an equal number of babies were assigned to each group using the blocking method.

Sample Size and Power

The study sample size was determined by the free software G* Power (Version 3.1. 9.2 by Franz Faul, University of Kiel, Kiel, Germany: 2014). In the power analysis that was performed prior to the study, the pain score variable cited in the study by Karakoç and Türker (23) was used. This power calculation (with β=0.14087 and α=0.05 risk, Power=0.85913) determined that 27 neonates should be included in each of the three groups. To account for attrition within the groups, the target sample for each group was inflated to achieve a total of 90 babies (n=30 facilitated tucking; n=30 white noise; n=30 white noise and facilitated tucking) (Figure 1).

The accessible population comprised 105 term neonates who were born healthy between July 1, 2017 - August 9, 2017, at the hospital in which the study was performed. The sample comprised 90 healthy term babies from the population who met the criteria for inclusion in the sample and whose mothers gave consent.

Procedures

Prior to the data collection, a researcher provided the mother of the neonate with information about the study and answered her questions. The researcher took the babies' anthropometric measurements (height, head, and lenght) before the blood draw with a tape measure and recorded the results. As suggested by the literature (3,12,36-39), the mothers were left with their babies for 30 minutes before the start of the study to engage in kangaroo care. Following this, the babies included in the study were transferred to the procedure room, which is a dimly lit, tranquil room, for the venipuncture procedure. The mothers were also taken into the room with the baby. This was performed between 05:00 a.m. - 07:00 a.m. when the environment is at its most quiet. The study was conducted by a total of 3 people, two nurses and one of the researchers. One of the nurses drew the blood. The other evaluated the pain independently of the researcher. Each baby's heel blood was drawn by the same nurse, and each baby's facilitated tucking was performed by the same researcher. The same nurses took part in the study each time. The nurse who would conduct the Neonatal Infant Pain Scale (NIPS) scoring was familiarized with how NIPS was to be measured. The nurse who would perform the heel-stick sampling was reminded of the technique to be use.

The neonates included in the study comprised three groups. These were the group listening to white noise, the group placed in the fetal position, and the group to which both were applied (fetal position + white noise). Blood was drawn from the lateral left heel of the infants in all three groups. The same type of needle-No. 21-was used in the procedure. The blood drawing procedure was performed for all the babies with the same technique, the same nurse and at the same physical conditions of the room setting. Additionally, a 70% alcohol solution was used. Only the babies whose blood could be drawn at the first try were taken into the study.

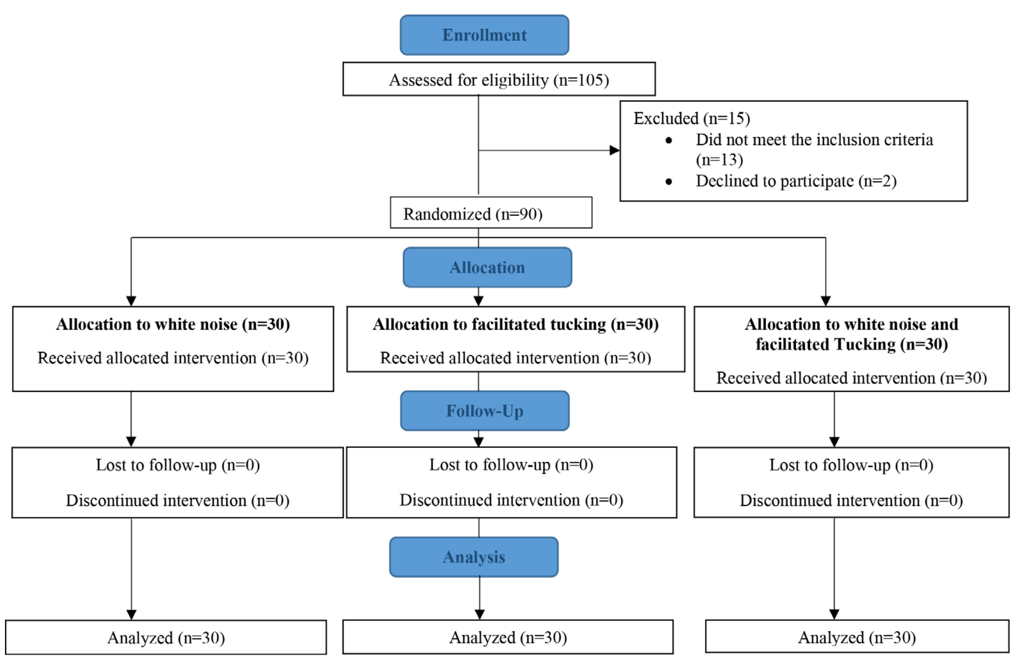

Figure 1. CONSORT flow diagram

Before the procedure, the researcher performed and recorded a respiration count for the babies. Additionally, a pulse oximeter was attached to the baby's right foot and the peak heart rate (PHR) and SpO_2 values were recorded. In each of the 3 groups, the researcher and the neonatal nurse independently scored the pain levels of the babies before the procedure according to NIPS and the results were recorded.

Experimental Group 1 listening to white noise. The babies listened to white noise produced with an X-brand MP3 player; an X-brand sound meter was used to measure the sounds and decibel levels of the environment. The sound meter was placed 50 cm away from the baby and the white noise sound level was adjusted to 55 decibels. Prior to the procedure, the baby's respiration was counted for 1 minute, after which a pulse oximeter was attached to the baby's right foot. The baby was then allowed to listen to the white noise for 2 minutes. During the procedure, the area from which the blood was to be drawn was wiped with the 70% alcohol solution and then left to dry for 30 seconds. Using a No. 21 needle, the experienced neonatal nurse drew the blood from the baby's left heel. The baby's respiration could not be counted during the procedure due to the baby's crying. The baby continued to be exposed to the white noise for one minute more after the blood draw had been completed. The researcher and the observing nurse each made an evaluation of the NIPS scores before, during and after the procedure.

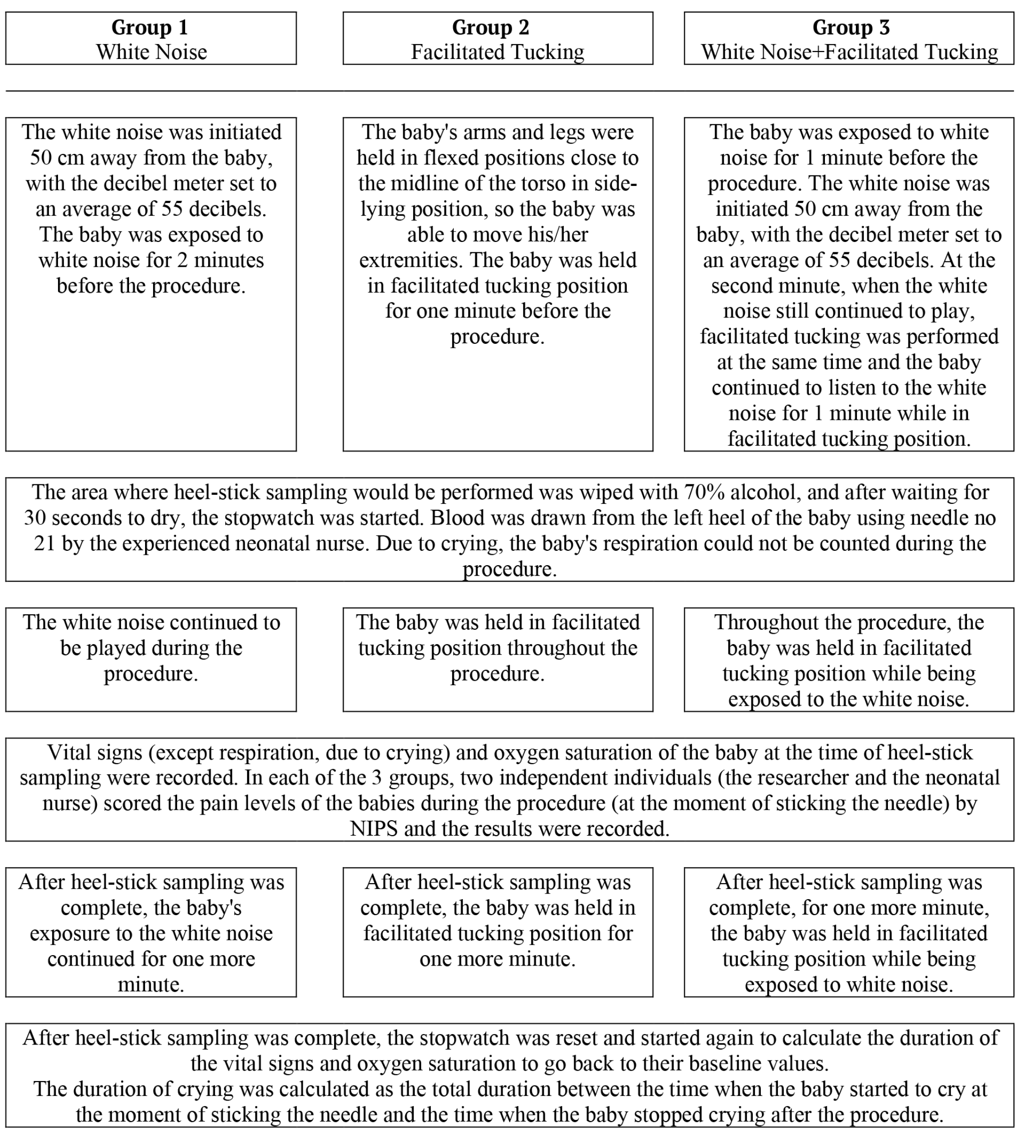

Figure 2. Research scheme

Experimental Group 2 placed in fetal position. The baby was placed lying on its side in the fetal position, with the upper and lower extremities manually flexed and positioned close to the body. The baby can move its extremities in this position. The baby's respiration was counted for one minute before the procedure and then a pulse oximeter was attached to the baby's right foot. The researcher held the baby in the fetal position for one minute and continued to hold the baby in this position during the procedure as well. The area from which the blood would be drawn from the heel was wiped with a 70% alcohol solution and left to dry for 30 seconds. Using a No. 21 needle, the experienced neonatal nurse drew the blood from the baby's left heel. The baby's respiration could not be counted during the procedure due to the baby's crying. The baby continued to be left in the fetal position for one minute after the blood draw had been completed. The researcher and the observing nurse each made an evaluation of the NIPS scores before, during and after the procedure.

Experimental Group 3 exposed to white noise + placed in fetal position. Prior to the procedure, the baby's respiration was counted for 1 minute, after which a pulse oximeter was attached to the baby's right foot. The baby was then allowed to listen to the white noise for 1 minute. At the start of the second minute, the baby was placed and kept in the fetal position for 1 minute and continued to be exposed to the sound of the white noise. Then, the area from which the blood was to be drawn was wiped with the 70% alcohol solution and left to dry for 30 seconds. Using a No. 21 needle, the experienced neonatal nurse drew the blood from the baby's left heel. The baby's respiration could not be counted during the procedure due to the baby's crying. The baby continued to be exposed to the white noise for one minute more after the blood draw had been completed. At the end of the procedure, the researcher/author and the nurse participating in the NIPS each made their own evaluation independently of each other.

The pain scores of the babies before, during, and after the procedure were independently evaluated by the researcher and the nurse who was not performing the heel-stick sampling. Cohen's kappa test was used to test the consistency of the scores given to the same situation by the nurse and the researcher in the evaluation of the NIPS pain scores. The ratings of the two individuals are completely compatible (Kappa Coefficient=0.953, p=0.027) (Figure 2).

Instruments

Data Collection Tools

A "Neonatal Introductory Information Form", "Data Evaluation Form" and the "NIPS" were used in the collection of data.

The Neonatal Introductory Information Form was developed by the researchers based on the literature (17,23,40). This form contains questions about the baby's characteristics.

The Data Evaluation Form includes questions about the neonate's PHR before, during and after the procedure, oxygen saturation, respiration rate, NIPS score, duration of the procedure, duration of crying, and the time required for the recovery of the peak heart rate, respiration, and oxygen saturation.

NIPS was used in the evaluation of the neonates' pain. This scale was developed by Lawrence et al. (41) (1993). The validity and reliability of the Turkish version of the test were assessed in 1999 by Akdovan (42), who reported Cronbach's alpha coefficient of consistency to be 0.83 during a vaccination procedure. Cronbach's alpha was 0.75 in the treatment group and 0.88 in the control group during the procedure. There are six variables related to the baby in the scale, namely, facial expression, crying, breathing patterns, arms, legs, and state of arousal. These variables are scored between 0-1. Only crying is scored between 0-2. The total score is between 0-7. The resulting score is directly proportional to the severity of the pain. That is, as the score increases, the severity of the pain increases.

The "white noise" used in our study is a fragment taken from the second part of the "Kolik" (Colic) album of Buzuki Orhan Osman, which has been used in similar studies (23,30). Orhan Osman and Neslihan Osman developed the white noise based on Dr. Harvey Karp's "The Happiest Baby," which comprises womb sounds. Orhan Osman performed frequency adjustments on these sounds and also added his own compositions under the various frequencies. An MP3 player and an X-brand decibel meter were used to measure the sound level that would be used in exposing the babies to the white noise. The decibel meter was placed 50 cm away from the baby and the white noise level was set to 55 decibels on average.

Statistical Analysis

Data were analyzed by using the International Business Machines (IBM) Statistical Package for Social Sciences (SPSS 21) (IBM Corp. Released 2012. IBM SPSS Statistics for

Windows, Version 21.0. Armonk, NY: IBM Corp.) statistical package programs. The normality of data was evaluated with the Shapiro-Wilk test for goodness of fit. Categorical data were expressed as frequency (n) and percentage (%). Continuous data were described in medians (Q1-Q3). Comparisons of the three groups (methods) were performed with the Kruskal Wallis-H test for non-normally distributed data. The Monte Carlo Chi-square test was used for the analysis of the cross tables created. For paired comparisons, the Mann-Whitney U test was used for non-normally distributed data. Spearman's correlation analysis was used to determine the relationship between two variables with non-normally distributed fit. The statistical significance level was accepted as p<0.05.

Ethical Approval

This study was approved by the Clinical Research Ethical Committee, of Eskişehir Osmangazi University Medical Faculty (approval date/number: 30.06.2017/80558721/188/01). Only babies from parents who gave their informed consent were included in the study. All protocols conformed to the ethical guidelines of the 2013 Helsinki Declaration. In addition, the aim of the study was explained, and written and oral permission from the mothers was obtained. The required permissions were obtained for the NIPS scale and the white noise album used in this study.

Results

All of the babies included in the study were term infants, accompanied by their mother; their overall condition was good, and they did not have any prior history of surgery. Babies who were admitted to the neonatal intensive care unit for various reasons (hyperthermia, respiratory distress, hyperbilirubinemia) were excluded from the study. Only two invasive procedures had been previously applied to any of the babies in our study was. These invasive interventions were IM vitamin K administration immediately after birth and an IM Hepatitis B injection. The babies in our study had not been given analgesics or sedative drugs in the last 24 hours and had not undergone any painful interventions in the last hour. The infants were fed within the last half-hour before the heel-stick sampling. All the babies included in the sample were fed orally. This allowed homogeneous distribution of the variables among the study groups.

Table I and Table II presents neonatal characteristics and inter-group similarities. It was found that there were no significant differences between the groups in terms of these characteristics, and the groups were similar (p>0.05). Sixty-four (71.1%) of the babies in the study were breast fed, 24 (26.7%) received breast milk + formula, and 2 (2.2%) were only fed formula (Table I).

Table III provides data on some of the physiological parameters and the NIPS scores of the neonates before the procedure. No significant differences were found between the groups in terms of PHR and NIPS before the procedure, and the groups were similar (p>0.05). There was a significant difference between the white noise group and the facilitated tucking group in terms of the respiratory and oxygen saturation rates of the neonates before the procedure (p<0.05). However, the respiration and oxygen saturation of the neonates in all groups before the procedure was within normal limits.

A comparison of the NIPS scores of the neonates during the procedure can be seen in Table IV. Table IV shows PHR, oxygen saturation and crying measures during the procedure, along with inter-group comparisons. The pain score of the group that listened to white noise and had been placed in the facilitated tucking position during the application was significantly lower than in the other two groups (p<0.001). Moreover, the pain score of the white noise group was significantly lower than in the facilitated tucking group. In this study, procedural peak heart rates were higher in the facilitated tucking position group (p<0.05) and a significant difference was detected between the groups in terms of total duration of crying (p<0.001). The group with the shortest duration of crying was the group that had listened to white noise and been simultaneously placed in the facilitated position. Furthermore, the duration of crying was longer in the facilitated tucking group than in the white noise group. No difference was found in this study between the oxygen saturation rates of the newborns during the procedure (p>0.05).

Discussion

One of the primary responsibilities of nurses working in neonatal units is pain management in infants. Various non-pharmacological interventions have demonstrated efficacy in preventing and relieving pain in infants undergoing painful procedures (43,44). It is important that these methods are effective, low-risk and cost-effective (45).

Various factors such as gestational age, gender, mode of delivery, nutrition and diet are important in pain perception and pain response in infants (46). It was found in this study that there were no significant differences between the groups in terms of these characteristics, and the groups were similar (p>0.05). Sixty-four (71.1%) of the babies in the study were breast fed, 24 (26.7%) received breast milk + formula, and 2 (2.2%) were only fed formula (Table I).

Physiological symptoms such as heart rate, blood pressure, breathing pattern, and oxygen saturation are used to assess pain caused by acute procedures (46). In this study, no difference was found between the peak heart rates, respiratory rates and oxygen saturation rates of the newborns before the procedure (p>0.05). However, post-procedural peak heart rates were higher in the facilitated tucking group (p<0.05). According to synactive theory, the facilitated stretching position is a non-pharmacological pain modality that helps infants conserve energy, feel safe, calm themselves, and reduce oxygen consumption (47,48). To reduce the pain of the neonate during heel-stick sampling in our study, we found that the combined application of white noise and facilitated tucking was the most effective method of pain control (p<0.001) (Table IV). No studies were found in the literature on the effect of the concerted

Table I. Neonatal characteristics and their inter-group comparison (n=90)

Variables		White noise		Facilitated tucking		White noise + Facilitated tucking		Total		Statistics†	p-value
		n	%	n	%	n	%	n	%		
Gestational age	38 weeks	10	33.34	10	33.33	10	33.33	30	100.00	0.001	1.000
	39 weeks	10	33.34	10	33.33	10	33.33	30	100.00		
	40 weeks	10	33.34	10	33.33	10	33.33	30	100.00		
Mode of delivery	Vaginal	7	30.40	4	17.40	12	52.20	23	100.00	5.724	0.057
	Cesarean sect.	23	34.30	26	38.80	18	26.90	67	100.00		
Sex	Female	16	34.80	15	32.60	15	32.60	46	100.00	0.089	0.957
	Male	14	31.80	15	34.10	15	34.10	44	100.00		
Mode of nutrition	Mother milk	20	31.30	23	35.90	21	32.80	64	100.00	1.969	0.795
	Mother milk + formula	9	37.50	6	25.00	9	37.50	24	100.00		
	Formula	1	50.00	1	50.00	0	0.00	2	100.00		

†Monte Carlo chi-square

Table II. Postnatal age and anthropomorphic measurements of the neonates at the time of birth and inter-group comparison (n=90)

Variables			n	Median (Q1-Q3)	Statistics‡	p-value
Postnatal age (days)		White noise	30	2.00 (1.00-3.00)	3.504	0.173
		Facilitated tucking	30	2.50 (2.00-3.00)		
		White noise + Facilitated tucking	30	2.00 (1.00-3.00)		
Birth	Weight (gr)	White noise	30	3435.00 (3007.50-3558.75)	3.011	0.222
		Facilitated tucking	30	3130.00 (2952.50-3495.00)		
		White noise + Facilitated tucking	30	3340.00 (3007.50-3527.50)		
	Length (cm)	White noise	30	50.00 (49.00-50.00)	0.101	0.951
		Facilitated tucking	30	50.00 (49.00-50.25)		
		White noise + Facilitated tucking	30	50.00 (49.00-50.00)		
	Head circumference (cm)	White noise	30	35.00 (35.00-36.00)	1.904	0.386
		Facilitated tucking	30	35.00 (35.00-36.00)		
		White noise + Facilitated tucking	30	35.00 (35.00-35.00)		
		Facilitated tucking	30	32.00 (32.00-33.00)		
		White noise + Facilitated tucking	30	32.00 (32.00-33.00)		

‡Kruskal-Wallis H

Table III. Respiration, peak heart rate, oxygen saturation and nıps scores of the neonates before the procedure and inter-group comparison (n=90)

Variables		n	Median (Q1-Q3)	Statistics‡	p-value	Multiple comparison
Respiratory	White noise	30	58.00 (56.00-58.50)	8.570	**0.014**	1-2
	Facilitated tucking	30	56.00 (54.00-56.50)			
	White noise + Facilitated tucking	30	56.00 (55.50-58.50)			
Heart rate	White noise	30	135.00 (130.00-140.00)	1.435	0.488	
	Facilitated tucking	30	138.00 (131.50-140.00)			
	White noise + Facilitated tucking	30	135.00 (130.00-140.00)			
Oxygen saturation (%)	White noise	30	97.00 (97.00-98.00)	10.884	**0.004**	1-2
	Facilitated tucking	30	98.00 (98.00-98.00)			
	White noise + Facilitated tucking	30	98.00 (97.00-98.00)			
NIPS score	White noise	30	0.00 (0.00-0.00)	0.001	1.000	
	Facilitated tucking	30	0.00 (0.00-0.00)			
	White noise + Facilitated tucking	30	0.00 (0.00-0.00)			

‡Kruskal-Wallis H
1=White noise; 2=Facilitated tucking; 3=White noise + Facilitated tucking

Table IV. NIPS scores, peak heart rates and oxygen saturations and crying of the neonate groups during the procedure and inter-group comparison (n=90)

Variables		n	Median (Q1-Q3)	Statistics‡	p-value	Multiple comparison
NIPS score	White noise	30	4 (3-4)	53.168	**<0.001**	1-2 2-3 1-3
	Facilitated tucking	30	4 (4-5)			
	White noise + Facilitated tucking	30	2 (2-3)			
Heart rate	White noise	30	165.00 (161.50-167.25)	40.584	**<0.001**	1-2 2-3 1-3
	Facilitated tucking	30	168.00 (165.75-173.25)			
	White noise + Facilitated tucking	30	160.00 (158.00-164.00)			
Oxygen saturation	White noise	30	90.00 (89.00-90.00)	2.261	0.270	
	Facilitated tucking	30	90.00 (90.00-92.00)			
	White noise + Facilitated tucking	30	90.00 (89.00-90.00)			
Total crying time/second (during procedure + after procedure)	White noise	30	79.00 (71.75-90.00)	42.874	**<0.001**	2-3 1-3
	Facilitated tucking	30	80.00 (73.75-85.50)			
	White noise + Facilitated tucking	30	56.00 (50.00-62.50)			

‡Kruskal-Wallis H
1=White noise; 2=Facilitated tucking; 3=White noise + Facilitated tucking

application of these two methods on pain. However, several studies on the pain caused by interventional procedures performed on neonates (16-18) showed that facilitated tucking was effective whereas other studies (22-24,49) indicated that white noise was effective. The result of our study is important since we demonstrated that the combined application of white noise and facilitated tucking during heel-stick sampling is more effective than the use of either one of the methods alone. In another study, Ren et al. (49) examined the clinical effect of white noise applied together with glucose on reducing the procedural pain of retinopathy screening in premature infants, finding that the use of white noise in combination with glucose reduced procedural pain and stabilized vital signs in premature infants. This can be explained by the fact that when the neonate hears the accustomed sounds of intrauterine life, this establishes a sense of trust, reduces the neonate's stress, and calms the infant, thus reducing the effect of the pain produced by the intervention.

Another result of our study was that the pain score of the white noise group during heel-stick sampling was significantly lower than in the facilitated tucking group ($p<0.001$) (Table IV). Music is known to increase the release of endorphins and have a calming effect (50). Neonates are sensitive to white noise, which has a wide frequency spectrum (31). It is known that the baby is affected by maternal heartbeats even when still in the womb, and that hearing this familiar sound and rhythm after birth has a calming effect (30) and shortens the duration of crying (17,18,20). Facilitated tucking is a reliable, nonpharmacological method of reducing the acute pain of interventions (16-18,20). The reason behind this can be the release of endorphins produced after facilitated tucking is applied to the neonate. The literature reports that endorphins block the transmission of pain, preventing the stimulus from reaching the level of consciousness, and suppressing receptors such as histamine and brady quinine (50). The greater efficiency of white noise compared to facilitated tucking in reducing pain can be explained by the fact that the neonate's attention is focused on another stimulant other than the pain, thereby reducing the pain score. The results of our study are important as they demonstrate that in the event that both of these methods cannot be applied together, white noise should be preferred over facilitated tucking.

Pain can cause behavioral and physiological changes. In neonates, physiological parameters such as PHR, respiration and oxygen saturation as well as behavioral variables such as crying can be useful in the evaluation of pain that cannot be expressed orally (40).

Based on this information, the groups in our study were compared in terms of the PHR and oxygen saturation of the neonates during the procedure (Table IV). No significant difference was detected between the groups in terms of oxygen saturation during the procedure ($p>0.05$). Similar to our study, some other studies on facilitated tucking detected no differences in terms of oxygen saturation (17,20). In our study, a significant difference was detected between the groups in terms of PHR during the procedure ($p<0.001$). The group with the lowest PHR during the procedure was the group to which a combination of white noise and facilitated positioning was applied. There are no studies in the literature that compare these three groups. Moreover, in our study, the PHR value of the white noise group was lower than in the facilitated tucking group. Studies in the literature report that facilitated tucking reduces PHR during heel-stick sampling (17,20,28). Contrary to these results, however, in an experimental study by Liaw et al. (17) it was found that facilitated tucking during venipuncture did not have a significant effect on PHR, as compared to a control group that was under routine care. In the study by Karakoç and Türker (23), conducted to identify the effect on pain of holding, white noise, and the combined use of holding and white noise, it was found that the PHR value was lower in the white noise group than in the other groups.

One of the most important reactions to pain is crying (28). In our study, a significant difference was detected between the groups in terms of the total duration of crying ($p<0.001$) (Table IV). The group with the shortest duration of crying was the group that was exposed to white noise and simultaneously placed in the facilitated tucking position. Moreover, the duration of crying was longer in the facilitated tucking group than in the white noise group. In the literature, facilitated tucking is reported to reduce the duration of crying during heel-stick sampling as well as regulate the sleep-wake cycle after heel-stick (17,28). In the study by Balcı (30) with babies diagnosed with colic, it was found that 0-3-month-old babies who were exposed to white noise slept for a longer duration and cried/screamed for a shorter duration than the control group. In the study by Karakoç and Türker (23), Ren et al. (49), Kahraman et al. (22) and Cetinkaya et al. (21), the duration of crying and pain scores was shorter in babies exposed to white noise.

The results of the present study showed that in the group of babies to which a combination of white noise and fetal positioning was applied, crying durations, heart beats, respiration and oxygen saturation returned to normal in a significantly shorter period than in the other two groups.

In using these two non-pharmacological techniques in concert, the aim was to create an intrauterine environment for the baby. The outcome obtained may be associated with creating a comfortable and safe feeling for the baby during the heel-stick procedure by exposing the baby to both white noise that the infant can recognize and having the infant assume the fetal position, both of which are helpful to the baby in being more tolerant of the discomfort produced by the procedure.

It is accepted today that the heel-stick procedure is a significant source of pain for infants and may have a permanent effect. Compared to older children, infants may feel more pain in invasive procedures such as those performed with a needle. Depending upon the pain experienced, infants may exhibit short and long-term outcomes. Nurses should be aware of the pain caused by heel-stick sampling and accordingly use appropriate methods for pain relief. White noise and facilitated tucking are recommended as helpful options in cases where a method of pain control is required.

Study Limitations

A limitation of our study was that it included only term babies and the procedure of heel blood collection. The effectiveness of the study can be investigated in sick preterm babies as well.

A key limitation of the present study was the lack of blinding at any stage of the procedure and especially not in the assessment of outcomes.

The difficulty of our study was that the same three nurses were needed to perform the study the nurse who was one of the authors, another nurse to draw the blood, and a third to make the assessment. The procedure and the assessment should be carried out on the same day, but due to the nurses' shift schedules, the study could not be carried out on days when shifts did not coincide, which led to the prolongation of the work.

At the hospital where the study took place, no pharmacological or non-pharmalogical intervention is performed on neonates during the routine procedure of heel-stick blood sampling. It is important that studies on painful procedures in neonates include new methods that are implemented in addition to evidence-based techniques. The babies in our study were given kangaroo care for 30 minutes prior to the procedure. The fact that sucrose or breastfeeding was not applied to the newborns during the heel-stick sampling procedure is another limitation of the study.

Conclusion

One of our conclusions is that the concerted use of white noise and facilitated tucking during heel-stick sampling is more effective than the use of either one of these methods alone. Another conclusion is that the use of white noise to reduce the pain of the neonate during heel-stick sampling is more effective than facilitated tucking. Our suggestion is that these methods can be used in instances where family-centered care cannot be provided during heel blood collection. It is up to nurses to use the available evidence, to facilitate the involvement of parents, and to explore the best ways of improving care for newborns.

Acknowledgments

The authors thank the nurses who performed the heel lancing procedure and pain assessment and all the mothers who agreed to participate in the study. The study was presented as an abstract oral presentation at the "2th International Congress On Nursing (ICON-2018)", April 13-15, 2018.

Ethics

Ethics Committee Approval: This study was approved by the Ethical Committee of Eskişehir Osmangazi University Medical Faculty (approval date/number: 30.06.2017/80558721/188/01).

Informed Consent: Informed consent was taken from the participants.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.P., Concept: A.P., A.A., Design: A.P., A.A., Data Collection and/or Processing: A.P., Analysis and/or Interpretation: A.P., Literature Search: A.P., A.A., Writing: A.P., A.A.

Conflict of Interest: No conflict of interest is declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Raja SN, Carr DB, Cohen M, et al. The revised International Association for the Study of Pain definition of pain: concepts, challenges, and compromises. Pain 2020; 161:1976-82.
2. Anand KJ; International Evidence-Based Group for Neonatal Pain. Consensus statement for the prevention and management of pain in the newborn. Arch Pediatr Adolesc Med 2001; 155:173-80.

3. Johnston C, Campbell-Yeo M, Disher T, et al. Skin-to-skin care for procedural pain in neonates. Cochrane Database Syst Rev 2017; 2:CD008435.
4. Gilad E, Arnon S. The Role of Live Music and Singing as a Stress-Reducing Modality in the Neonatal Intensive Care Unit Environment. Music Med 2010; 2:18-22.
5. Hockenberry M, Wilson D, Rodgers C. Wong's Essentials of Pediatric Nursing. 11th ed. Canada: Elsevier; 2021.
6. Benoit B, Martin-Misener R, Latimer M, Campbell-Yeo M. Breast-Feeding Analgesia in Infants: An Update on the Current State of Evidence. J Perinat Neonatal Nurs 2017; 31:145-59.
7. Erkul M, Efe E. Efficacy of Breastfeeding on Babies' Pain During Vaccinations. Breastfeed Med 2017; 12:110-5.
8. Cakirli M, Acikgoz A. A Randomized Controlled Trial: The Effect of Own Mother's Breast Milk Odor and Another Mother's Breast Milk Odor on Pain Level of Newborn Infants. Breastfeed Med 2021; 16:75-81.
9. Altun-Köroğlu O, Ozek E, Bilgen H, Cebeci D. Hindmilk for procedural pain in term neonates. Turk J Pediatr 2010; 52:623-9.
10. Harrison D, Larocque C, Bueno M, et al. Sweet solutions to reduce procedural pain in neonates: A meta-analysis. Pediatrics 2017; 139:e20160955.
11. Stevens B, Yamada J, Ohlsson A, Haliburton S, Shorkey A. Sucrose for analgesia in newborn infants undergoing painful procedures. Cochrane Database Syst Rev 2016; 7:CD001069.
12. Akcan E, Yiğit R, Atici A. The effect of kangaroo care on pain in premature infants during invasive procedures. Turk J Pediatr 2009; 51:14-8.
13. Johnston CC, Filion F, Campbell-Yeo M, et al. Kangaroo mother care diminishes pain from heel lance in very preterm neonates: a crossover trial. BMC Pediatr 2008; 8:13.
14. Diego MA, Field T, Hernandez-Reif M. Procedural pain heart rate responses in massaged preterm infants. Infant Behav Dev 2009; 32:226-9.
15. Hartling L, Shaik MS, Tjosvold L, Leicht R, Liang Y, Kumar M. Music for medical indications in the neonatal period: a systematic review of randomised controlled trials. Arch Dis Child Fetal Neonatal Ed 2009; 94:F349-54.
16. Alinejad-Naeini M, Mohagheghi P, Peyrovi H, Mehran A. The effect of facilitated tucking during endotracheal suctioning on procedural pain in preterm neonates: a randomized controlled crossover study. Glob J Health Sci 2014; 6:278-84.
17. Liaw JJ, Yang L, Katherine Wang KW, Chen CM, Chang YC, Yin T. Non-nutritive sucking and facilitated tucking relieve preterm infant pain during heel-stick procedures: a prospective, randomised controlled crossover trial. Int J Nurs Stud 2012; 49:300-9.
18. Lopez O, Subramanian P, Rahmat N, Theam LC, Chinna K, Rosli R. The effect of facilitated tucking on procedural pain control among premature babies. J Clin Nurs 2015; 24:183-91.
19. Aguirre Unceta-Barrenechea A, Saitua Iturriaga G, Sainz de Rozas Aparicio I, Riveira Fernández D. Analgesia when taking heel-lance blood in the newborn. An Pediatr (Barc) 2008; 69:544-7.
20. Peyrovi H, Alinejad-Naeini M, Mohagheghi P, Mehran A. The effect of facilitated tucking position during endotracheal suctioning on physiological responses and coping with stress in premature infants: a randomized controlled crossover study. J Matern Fetal Neonatal Med 2014; 27:1555-9.
21. Cetinkaya S, Yavas Celik M, Ozdemir S. Effect of white noise on alleviating the pain of new-born during invasive procedures. J Matern Fetal Neonatal Med 2022; 35:1426-32.
22. Kahraman A, Gümüş M, Akar M, Sipahi M, Bal Yılmaz H, Başbakkal Z. The effects of auditory interventions on pain and comfort in premature newborns in the neonatal intensive care unit; a randomised controlled trial. Intensive Crit Care Nurs 2020; 61:102904.
23. Karakoç A, Türker F. Effects of white noise and holding on pain perception in newborns. Pain Manag Nurs 2014; 15:864-70.
24. Kucukoglu S, Aytekin A, Celebioglu A, Celebi A, Caner I, Maden R. Effect of White Noise in Relieving Vaccination Pain in Premature Infants. Pain Manag Nurs 2016; 17:392-400.
25. Montagu A. Touching: The Human significance of the skin. Harper & Row. New York; 1978.
26. Efe E, Savaşer S. The effect of two different methods used during peripheral venous blood collection on pain reduction in neonates. Agri 2007; 19:49-56.
27. Cignacco E, Hamers JP, Stoffel L, et al. The efficacy of non-pharmacological interventions in the management of procedural pain in preterm and term neonates. A systematic literature review. Eur J Pain 2007; 11:139-52.
28. Pillai Riddell RR, Racine NM, Gennis HG, et al. Non-pharmacological management of infant and young child procedural pain. Cochrane Database Syst Rev 2015; 2015:CD006275.
29. Aydın D, Yıldız S. Effect of Turkish music that premature infants are made to listen during care on stress, oxygen saturation level and length of hospital stay. J Hum Sci 2014; 11:1343-59.
30. Balcı S. Effect of white noise in colicky baby. (Unpublished Master's Thesis) Marmara University; 2006.
31. Kushnerenko E, Winkler I, Horváth J, et al. Processing acoustic change and novelty in newborn infants. Eur J Neurosci 2007; 26:265-74.
32. Das R, Jana N, Arora N, Sengupta S. Ultrasound assessment of fetal hearing response to vibroacoustic stimulation. J Matern Fetal Neonatal Med 2020; 33:2326-32.
33. Dağoğlu T. Development of Infants and environmental factors. In: Dağoğlu T, Görak G, editors. Temel Neonatoloji ve Hemşirelik İlkeleri. 2th ed. Istanbul: Nobel Tıp Kitabevleri. (in Turkish); 2008. p. 759.
34. Whipple J. The effect of music-reinforced nonnutritive sucking on state of preterm, low birthweight infants experiencing heelstick. J Music Ther 2008; 45:227-72.
35. Bulut M, Küçük Alemdar D, Bulut A, Şalcı G. The Effect of Music Therapy, Hand Massage, and Kaleidoscope Usage on Postoperative Nausea and Vomiting, Pain, Fear, and Stress in Children: A Randomized Controlled Trial. J Perianesth Nurs 2020; 35:649-57.
36. Cong X, Cusson RM, Walsh S, Hussain N, Ludington-Hoe SM, Zhang D. Effects of skin-to-skin contact on autonomic pain responses in preterm infants. J Pain 2012; 13:636-45.
37. Gao H, Xu G, Gao H, et al. Effect of repeated Kangaroo Mother Care on repeated procedural pain in preterm infants: A randomized controlled trial. Int J Nurs Stud 2015; 52:1157-65.

38. Hall RW, Anand KJ. Pain management in newborns. Clin Perinatol 2014; 41:895-924.

39. Kemer D, İşler Dalgıç A. Evidence-Based Non-Pharmacological Nursing Procedures For Newborn Pain Management. Balıkesir Heal Sci J 2020; 9:197-204.

40. Acikgoz A, Yildiz S. Effects of Open and Closed Suctioning Systems on Pain in Newborns Treated with Mechanical Ventilation. Pain Manag Nurs 2015; 16:653-63.

41. Lawrence J, Alcock D, McGrath P, Kay J, MacMurray SB, Dulberg C. The development of a tool to assess neonatal pain. Neonatal Netw 1993; 12:59-66.

42. Akdovan T. Assessment of pain in healthy newborns, investigation of the effect of the sucking and holding method (Unpublished Master's thesis) [Internet]. Marmara University; 1999. Available from: https://scholar.google.com/scholar_lookup?title=Assessment of pain in healthy newborns%2Cinvestigation of the effect of the sucking and holding method&publication_year=1999&author=T. Akdovan

43. Cooney MF, Czarnecki M, Dunwoody C, et al. American Society for Pain Management Nursing position statement with clinical practice guidelines: authorized agent controlled analgesia. Pain Manag Nurs 2013; 14:176-81.

44. Czarnecki ML, Turner HN, Collins PM, Doellman D, Wrona S, Reynolds J. Procedural pain management: a position statement with clinical practice recommendations. Pain Manag Nurs 2011; 12:95-111.

45. American Academy of Pediatrics; American Academy of Pediatric Dentistry; Coté CJ, Wilson S; Work Group on Sedation. Guidelines for monitoring and management of pediatric patients during and after sedation for diagnostic and therapeutic procedures: an update. Pediatrics 2006; 118:2587-602.

46. Gardner S, Carter B, Enzman-Hines M, Niermeyer S. Merenstein & Gardner's Handbook of neonatal intensive care. 9th Editio. Elsevier; 2020.

47. Axelin A, Salanterä S, Lehtonen L. "Facilitated tucking by parents" in pain management of preterm infants-a randomized crossover trial. Early Hum Dev 2006; 82:241-7.

48. Hartley KA, Miller CS, Gephart SM. Facilitated tucking to reduce pain in neonates: evidence for best practice. Adv Neonatal Care 2015; 15:201-8.

49. Ren XF, Wang ZZ, Yang M, Li L, Kong XY, Feng ZC. Clinical effect of white noise combined with glucose in reducing the pain of retinopathy screening in preterm infants. Zhongguo Dang Dai Er Ke Za Zhi 2019; 21:1159-63.

50. Hall JE, Guyton A. Guyton and Hall: Textbook of Medical Physiology Fourteenth Edition. Vol. 14, Elsevier. 2021.