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The effects of acupressure and foot massage on pain during heel lancing in neonates: A randomized controlled trial

Tuba Koç Özkan*, Didem Şimşek Küçükkelepçe, Semiha Aydin Özkan

Adıyaman University School of Nursing, Midwifery Department, Altinsehir St., 02040 Adiyaman, Turkey

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ABSTRACT

Objective: To determine the effects of foot massage and acupressure on pain during heel lancing in neonates.
Methods: A randomized controlled trial was performed in a university hospital in Turkey between February and December 2018. The neonates were randomized into three groups as acupressure, massage, and control groups. Acupressure was applied to the neonates in the acupressure group, and massage was given to the neonates in the massage group for 2 min before the heel lancing procedure. Pain responses of the neonates in the groups was evaluated with the Neonatal Infant Pain Scale during and 1 min after the heel lancing procedure.
Results: The study was completed with 139 neonates including 46 neonates in the acupressure group, 47 neonates in the foot massage group, and 46 neonates in the control group. There were statistically significant differences between the acupressure, massage and control groups in terms of their mean NIPS scores during (4.30 ± 2.25, 3.95 ± 2.63, 6.04 ± 1.26; respectively) and 1 min after the heel lancing procedure (1.46 ± 1.46, 1.66 ± 1.66, 3.85 ± 1.37; respectively). There was a significant difference in NIPS scores between the intervention groups and the control groups ($p = 0.001$).
Conclusions: Acupressure and massage were effective in reducing pain in neonates during the heel lancing procedure. However, there was no statistically significant difference between acupressure and massage. Acupressure and massage techniques can be applied for procedural pain management in the newborn.

1. Introduction

Pain is an experience that affects people of all ages negatively, mentally, physically, and socially. The belief that neonates did not feel pain changed after the 1980s, and newborns have proven to feel pain.[1,2] Starting from birth until discharge, neonates are exposed to many interventions such as vitamin K and Hepatitis B vaccination. In addition, in our country heel lancing practice is performed before discharge from hospital in order to identify a number of diseases such as phenylketonuria, hypothyroidism and biotinidase deficiency.[3,4] Neonates experience pain during these practices which may prevent their adaptability to the outer world and lead to stress and physiological imbalance. Therefore, preventing and reducing pain in neonates is of great importance.[5,6] A number of evidence-based non-pharmacological methods are reported to be used for the acute pain experienced by the neonates. Some of these methods include kangaroo care, oral sucrose,[7,8] breast feeding[9] and music therapy[10,11] Acupressure and massage are also reported to reduce pain caused by the procedures such as heel lancing.[12–14]

Massage is a systematic and scientific procedure applied by using hands or special tools.[14,15] As for acupressure, it is a method applied by stimulating the acupuncture points using hands and fingers by applying pressure on the meridians in body.[12,16] Both methods are reliable, economical and easy to learn and apply. Review of the related literature indicates studies on the effectiveness of acupressure and foot massage on reducing pain in neonates.[2,17] However, no studies were found to have compared the effects of acupressure and foot massage on pain during heel lancing in neonates. Hence, this study aimed to identify the effects of foot massage and acupressure on pain during heel lancing.

2. Methods

2.1. Design

The study was conducted as a randomized controlled trial with the purpose of identifying the effects of acupressure and foot massage on pain during heel lancing in neonates.

* Corresponding author.
E-mail addresses: tkoc@adiyaman.edu.tr (T. Koç Özkan), dsimsek@adiyaman.edu.tr (D. Şimşek Küçükkelepçe), saydin@adiyaman.edu.tr (S. Aydin Özkan).

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2.2. Setting

The study was conducted between February and December 2018 with neonates in the postpartum services of a university hospital in Turkey.

2.3. Sample

The inclusion criteria were having 2500–4000 g body weight and being term neonates, having APGAR score of over 7 five minutes after birth, having no health problems detected in the newborn examination after birth, having received no painful interventions apart from Hepatitis B and vitamin K after birth, having received no acetaminophen or sucrose pacifier, being with the mother and being fed orally, having had breast milk within 30 min before heel lancing, and having a clean diaper.

Sample size was calculated based on the study conducted by Mir et al[18] (2018) that aimed to identify the effects of therapeutic touch and heel warming on the pain during the heel stick procedure. Similar to the present study, the variables in that study included non-pharmacological methods. Mir et al (2018) reported that NIPS pain scores after the procedure were 2.8 ± 1.6 in the heel warming group and 4.4 ± 1.7 in the control group. The study conducted with a total number of 78 neonates, 23 in each group, was found to have $\alpha = 0.05$ level, 89% confidence interval, and $d = 0.9692$ effect size. In this regard, this study was conducted with 50 neonates in each group and 150 neonates in total with a view to increasing the effect size of the study and taking data loss in the study process into consideration. Neonates were assigned in the acupressure, massage, and control groups with the closed envelope method. Cards written “acupressure”, “massage” and “control” on them were placed in closed envelopes, and the mothers were asked to choose one of these envelopes. This way, 50 neonates were assigned to the groups. A total number of 11 neonates were excluded from the study due to some reasons (Fig. 1). Hence, the study was completed with 46 neonates in the acupressure group, 47 neonates in the foot massage group, and 46 neonates in the control group.

2.4. Outcome measurements

An information form was prepared by the researchers using variables cited in previous investigations.[15,18] The form included questions about birth weight, gestational age, postnatal age, gender and delivery method.

Neonatal Infant Pain Scale (NIPS) was developed by Lawrence et al in 1993 in order to assess the pain responses of premature and term neonates. The scale consists of five behavioural sections and one physiological section including facial expression, crying, breathing, arm and leg movements, and alertness. Total scores range between 0 and 7. Scores from 0 to 2 indicate mild to no pain, 3 to 4 indicates mild to moderate pain, and > 4 indicates severe pain. Higher scores indicate more severe pain. In the study of Lawrence et al, Cronbach's Alpha of NIPS was found 0.92.[19] Adapted to Turkish by Akdovan, NIPS is used for the assessment of procedural pain of the premature and term neonates.[20] Cronbach's Alpha value was 0.87 in this study.

Pulse Oximeter Device calibrated Covidien Nellcor Pulse Oximeter Monitor (Nellcor Puritan Bennett Inc.made in Pleasanton, Korea) was used for the measurement of oxygen saturation and heart rate before, during and after heel lancing in all three groups.

Duration of crying and heel lancing procedure were recorded with two Apple brand iPhone 6 plus telephone chronometers.

2.5. Procedure

Prior to the study, the researcher received an acupressure certificate. Acupressure and foot massage were performed by the researcher (Tuba Koç Özkan-TKÖ) who had an acupressure certificate. NIPS pain assessment was performed by a researcher (Didem Şimşek Küçükkelepçe-DŞK). Physiological measurements were recorded by another researcher (Semiha Aydın Özkan-SAÖ). Duration of crying and duration of procedure were recorded by another researcher (Tuba Koç Özkan-TKÖ).

The heel lancing procedure was performed by the same nurse at the first attempt and at the same heel lancing procedure room. The room temperature was 22–24 °C. The light of the room was white fluorescent lamp during the heel lancing. Heel lancing was performed between 07.00 a.m. and 09.00 a.m.

2.5.1. Procedures performed to the neonates in three groups 5 min before the heel lancing

The researcher who conducted acupressure and massage practices visited the mother-baby pairs in their rooms and asked the mothers to choose one of the closed envelopes. All the procedures were explained, and verbal and written consent were taken from the mothers of the neonates to be included in the study. The information form that included the socio-demographic features of the neonates was filled in. The neonates were connected to the pulse oximeter monitor probe on the wrist. Their oxygen saturation and heart rate values were measured. Then neonates were taken to the procedure room to heel lancing by the nurse.

2.5.2. Procedures performed to the neonates in the interventions (acupressure/massage) group 2 min before heel lancing

Before the interventions were applied, the researcher washed her hands and kept them at body temperature. The interventions were performed when the nurse was holding the neonate on her arm.

For two minutes, acupressure was performed in the acupressure points (Kun Lun (UB60) and Taixi (K3). The acupuncture points Kun Lun (UB60) and Taixi (K3) are on the side of the ankle. These points are effective in reducing pain.[12,21] Each point was applied acupressure for 60 s, and heel lancing was performed right after this procedure.

Neonates in the massage group were given foot massage for two minutes, and heel lancing was performed right after the massage.

2.5.3. Procedures performed to the neonates in all three groups during heel lancing

The area to be applied heel lancing was cleaned using 70% alcohol and left to dry for 30 s. Heel lancing was performed by an experienced nurse from the heel of the neonates with a 21-gauge needle. As soon as the needle was pricked, the chronometer was started, and the time when the procedure ended was recorded. The other chronometer was started once the neonate started to cry, and the time when s/he stopped crying was recorded. Neonates’ pain during heel lancing was assessed; oxygen saturation and heart rate values were recorded.

2.5.4. Practices performed to the neonates in all three groups 1 min after heel lancing

Neonates’ pain was reassessed 1 min after heel lancing was finished. Oxygen saturation and heart rates were assessed again.

2.6. Data analysis

The collected data were evaluated using Statistical Package for the Social Sciences SPSS Statistics 22.0 (SPSS Inc., Chicago, IL, USA). Descriptive characteristics of the neonates were analysed using descriptive statistics (percentage, mean, standard deviation). When the data were evaluated according to the normality tests, it was found that they showed normal distribution. Group differences of descriptive characteristics were analysed using one-way ANOVA and Chi-square test. Ancova test was performed to determine whether the variables (gender, gestational age) affect pain. Differences on pain between and within groups were analysed using one-way ANOVA and independent *t*-test respectively. Differences in physiological parameters between and

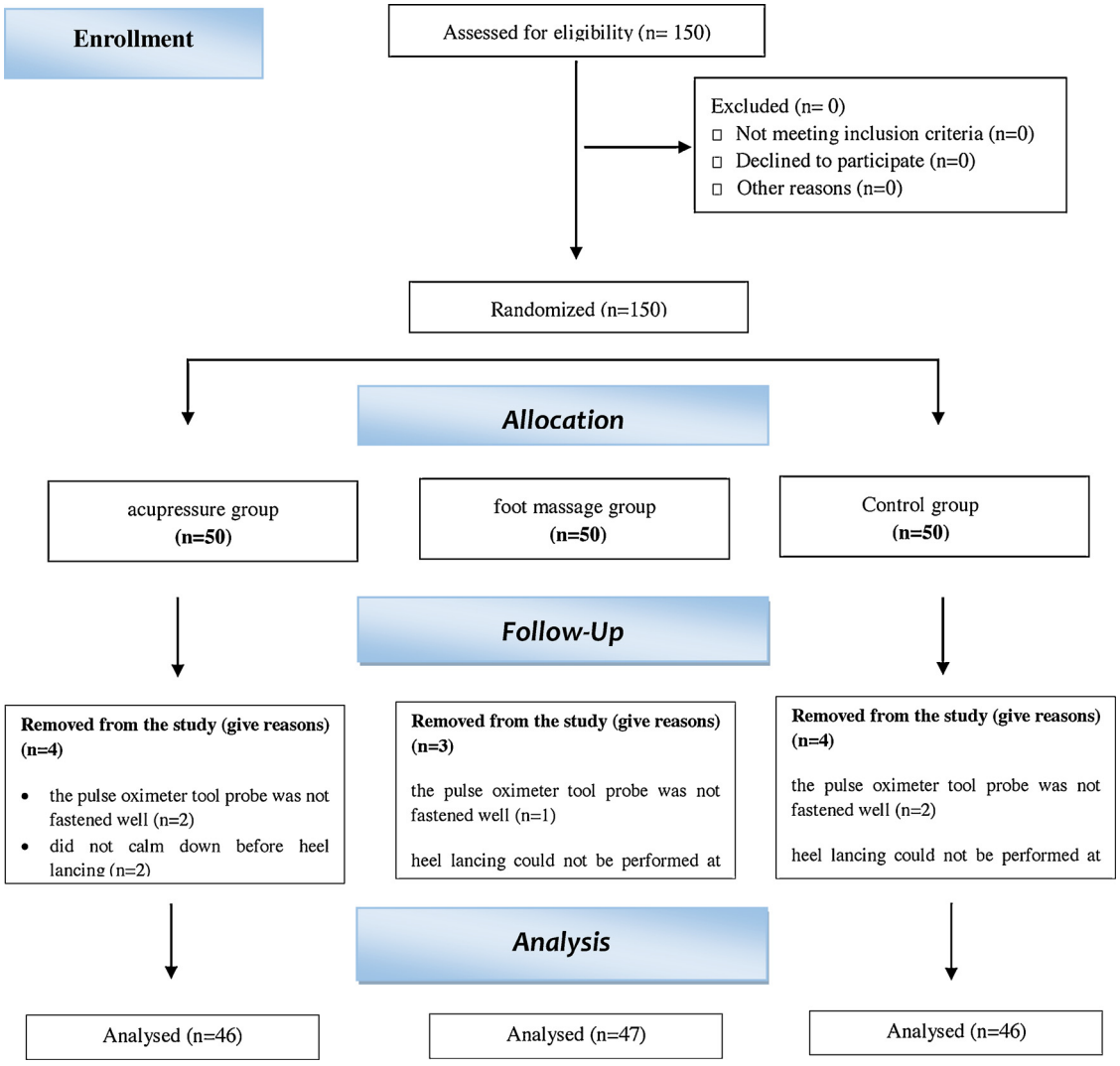

Fig. 1. CONSORT flow diagram.

within groups were analysed using one-way ANOVA and Repeated Measures ANOVA respectively. Differences on the duration of crying and heel lancing procedure between the groups were analysed using one-way ANOVA. Significance was assessed at the level of $p < 0.05$.

2.7. Ethical considerations

Ethical approval was received from Adiyaman University Ethical Committee (2018/1–5). The aim of the study was explained to the mothers and written informed consent was obtained from each mother.

The study registered in Clinical Trial Registry (NCT03906552).

3. Results

The neonates' birth weight, gestational and postnatal age, gender, and mothers' birth type displayed similar distributions between the groups ($p > 0.05$) (Table 1).

When the effect of gender among the groups on pain during and after heel lancing was evaluated by ANCOVA test, it was found that gender had no effect on pain ($F = 0.154$ $p = 0.695$; $F = 0.195$ $p = 0.660$; respectively). When the effect of gestational age among the groups on pain during and after heel lancing was evaluated by ANCOVA test, it was found that gestational age had no effect on pain ($F = 0,060$ $p = 0,806$; $F = 0.284$ $p = 0.595$; respectively).

NIPS pain mean scores during the heel lancing were 4.30 ± 2.25 in the acupressure group, 3.95 ± 2.63 in the massage group, and 6.04 ± 1.26 in the control group. There was no statistically significant between the acupressure and massage groups in terms of the NIPS scores ($p > 0.05$). The NIPS scores of the neonates in the acupressure and massage groups were significantly lower than the control group ($p < 0.05$). (The mean difference (SE) and 95% confidence interval (CI) of the mean difference between groups = control-acupressure: 1.73 ± 0.38 and 0.98–2.49; control-massage: 2.08 ± 0.42 and 1.23–2.93; acupressure-massage: 0.34 ± 0.50 and 0.66–1.35) (Table 2).

NIPS pain mean scores 1 min after the heel lancing were 1.46 ± 1.46 in the acupressure group, 1.66 ± 1.66 in the massage group, and 3.85 ± 1.37 in the control group. The NIPS scores of the neonates in the acupressure and massage groups were significantly lower than the control group ($p < 0.05$). (SE and CI = control-acupressure: 2.39 ± 0.29 and 1.80–2.97; control-massage: 2.18 ± 0.31 and 1.56–2.81; acupressure-massage: 0.20 ± 0.32 and 0.84-0.44) (Table 2).

There was a significant decrease in the pain mean scores after heel lancing according to the order of the during the heel lancing procedures within groups ($p < 0.05$) (Table 2).

Oxygen saturation between the groups was found to be statistically significant during the heel lancing ($p = 0.009$) (SE and CI = control-acupressure: 1.63 ± 0.60 and 2.83-0.42; control-massage: 2.04 ± 0.69 and 3.41-0.66; acupressure-massage: 0.41 ± 0.75 and

Table 1
The comparison of the descriptive characteristics of the neonates in the groups (N = 139).

Characteristics	Acupressure Group n = 46		Massage Group n = 47		Control Group n = 46		Total		Statistics
	$\bar{x} \pm SD$		$\bar{x} \pm SD$		$\bar{x} \pm SD$		$\bar{x} \pm SD$		
Birth weight	3.3 ± 3.9		3.2 ± 4.4		3.3 ± 3.6		3.2 ± 4.0		F = 0.620
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	p = 0.540
Gestational age (weeks)									
38	21	45.7	25	53.2	25	54.3	71	51.1	X^2=5.731
39	19	41.3	10	21.3	14	30.4	43	30.9	p = 0.220
40	6	13.0	12	25.5	7	15.2	25	18.0	
Postnatal age (day)									
1	22	47.8	24	51.1	21	45.7	67	48.2	X^2=0.277
2	24	52.2	23	48.9	25	54.3	72	51.8	p = 0.871
Gender									
Male	27	37.0	20	27.4	26	35.6	73	52.5	X^2=2.871
Female	19	28.8	27	40.9	20	30.3	66	47.5	p = 0.238
Delivery method									
Vaginal	19	36.5	19	36.5	14	26.9	52	37.4	X^2=1.436
Caesarean	27	31.0	28	32.2	32	36.8	87	62.6	p = 0.488

F:One-way Anova ANOVA.
X^2:Chi Square test.

Table 2
The comparison of the pain scores of neonates in the groups.

NIPS Pain Scale	Acupressure Group n = 46 $\bar{x} \pm SD$	Massage Group n = 47 $\bar{x} \pm SD$	Control Group n = 46 $\bar{x} \pm SD$	Statistics
During the heel lancing	4.30 ± 2.25	3.95 ± 2.63	6.04 ± 1.26*	F = 12.728 p = 0.001
1 minute after the heel lancing	1.46 ± 1.46	1.66 ± 1.66	3.85 ± 1.37*	F = 36.050 p = 0.001
Statistics	t = 13.977 p = 0.001	t = 9.450 p = 0.001	t = 10.130 p = 0.001	

F = One Way ANOVA.
t = independent *t*-test.
* Tukey test.

1.90-1.08). According to the oxygen saturation measurements performed in three different times within groups, oxygen saturation was lowest during the heel lancing procedure (Table 3). Oxygen saturation p value measured one minute after heel lancing was found to be at border line; although this difference was not statistically significant, it was found to be clinically significant (p = 0.052) (SE and CI = control-acupressure: 1.21 ± 0.51 and 2.23-0.19; control-massage: 0.97 ± 0.52 and 2.01-0.06; acupressure-massage: 0.24 ± 0.52 and 0.81–1.29) (Table 3). The heart rate values of the neonates in the massage group were significantly higher than the control group one minute after the heel lancing procedure (SE and CI = control-acupressure: 3.23 ± 2.22 and 2.23-0.19; control-massage: 8.49 ± 2.76 and 13.98-3.00; acupressure-massage: 5.25 ± 2.76 and 10.74-0.23). ($p < 0.05$) (Table 3).

Duration of crying and heel lancing procedure of the neonates was recorded during the heel lancing. Hence, the duration of crying was 79.32 ± 56.93 s in the acupressure group, 46.81 ± 40.88 s in the massage group, and 106.33 ± 62.39 s in the control group. The duration of crying was significantly shorter in the massage group than the acupressure and control group ($p < 0.05$) (SE and CI = control-acupressure: 27.00 ± 12.45 and 2.25–51.74; control-massage: 59.51 ± 10.91 and 37.83–81.19; acupressure-massage: 32.51 ± 10.26 and 12.13–52.89) (Table 4).

Table 3
The comparison of physiological parameters of the neonates in the groups.

Physiological parameters	Acupressure Group n = 46 $\bar{x} \pm SD$	Massage Group n = 47 $\bar{x} \pm SD$	Control Group n = 46 $\bar{x} \pm SD$	Statistics
Oxygen saturation				
Before the heel lancing	95.78 ± 2.36	96.48 ± 2.16	96.36 ± 2.31	F = 1.271 p = 0.284
During the heel lancing	92.60 ± 3.25	93.02 ± 3.96*	90.97 ± 2.53*	F = 4.934 **p = 0.009**
After the heel lancing	95.30 ± 2.49	95.06 ± 2.60	94.08 ± 2.43	F = 3.028 **p = 0.052**
Statistics	F = 16.285 p = 0.001	F = 11.304 p = 0.001	F = 101.759 p = 0.001	
Heart rate				
Before the heel lancing	134.82 ± 10.69	134.57 ± 11.47	130.69 ± 10.12	F = 2.128 P = 0.123
During the heel lancing	161.21 ± 15.74	159.23 ± 18.84	158.54 ± 15.86	F = 0.311 p = 0.733
After the heel lancing	144.06 ± 10.7	149.91 ± 15.47*	140.82 ± 10.67*	F = 5.460 **p = 0.005**
Statistics	F = 79.282 p = 0.001	F = 67.250 p = 0.001	F = 100.894 p = 0.001	

a = One way ANOVA.
b = Repeated Measures ANOVA.
* Tukey test.

Table 4
The comparison of the duration of crying and heel lancing procedure of neonates in the groups.

Time (Second)	Acupressure Group n = 46 $\bar{x} \pm SD$	Massage Group n = 47 $\bar{x} \pm SD$	Control Group n = 46 $\bar{x} \pm SD$	Statistics
Duration of crying	79.32 ± 56.93	46.81 ± 40.88*	106.33 ± 62.39	F = 14.123 p = 0.001
Duration of heel lancing	125.46 ± 59.50	82.09 ± 26.22*	151.91 ± 80.06	F = 16.419 p = 0.001

F = One Way ANOVA.
$p < 0.05$.
* Tukey test.

The duration of heel lancing procedure was 125.46 ± 59.50 s in the acupressure group, 82.09 ± 26.22 s in the massage group, and 151.91 ± 80.06 s in the control group. The duration of heel lancing procedure was significantly shorter in the massage group than the acupressure and control group ($p < 0.05$) (SE and CI = control-acupressure: 26.45 ± 14.70 and 2.76–55.67; control-massage: 69.82 ± 12.30 and 45.39–94.26; acupressure-massage: 43.37 ± 9.50 and 24.50–62.24) (Table 4).

4. Discussion

It is important to use non-pharmacological methods in order to decrease pain in procedures such as heel lancing.[24] Abbasoğlu et al,[12] in their study conducted with preterm neonates, reported that acupressure applied to BL60 and K3 points before heel lancing decreased pain. Ibrahim et al[13] found that foot massage applied before heel lancing decreased pain in preterm neonates. In their study conducted with neonates, Chen et al[24] found that non-invasive acupuncture applied before heel lancing decreased pain. Zargham-Boroujeni, Elsagh & Mohammadizadeh,[5] in their study that aimed to identify the effects of massage and breastfeeding on response to venepuncture pain among neonates, found that massage applied before venepuncture reduced pain. Pain in neonates who were applied acupressure and massage was found to be statistically significantly lower. This case showed that acupressure and massage decreased pain, but there was no superiority of acupressure and massage to each other in terms of decreasing pain. This finding indicated that efficiency of acupressure and massage in decreasing pain was similar to each other, which was considered to result from the fact that both methods were effective in decreasing pain through tactile ways.

Perception of pain in neonates is affected by factors such as birth weight, gestational week, postnatal age, gender, and type of birth.[22,23] This study indicated no differences between the acupressure, massage and control group neonates in terms of birth weight, gestational weeks, postnatal age, gender, and type of birth. Similar features in all three groups indicated that neonates' reaction to pain caused by heel lancing would be similar.

Physiological variables are the parameters that support pain assessment[5,25,26] Jain, Kumar & McMillan,[1] in their study that identified the effect of massage on the pain during heel lancing, found that there were no significant differences between the groups of oxygen saturation values before, during and after the procedure and that heart rate was statistically significantly lower in the massage group. Chen et al,[24] in their study conducted with neonates in order to identify the effect of auricular non-invasive magnetic acupuncture on the pain during heel lancing, found that there were no significant differences between the heart rate and oxygen saturation values before, during and after the procedure. When the groups were evaluated within each other, significant differences were detected in the oxygen saturation and heart rate values before, during and 1 min after the procedure. This finding indicated that neonates in all three groups felt pain due to heel lancing. In addition, the assessment between the groups showed that oxygen saturation was significantly different during heel lancing, and heart rate was significantly different 1 min after the procedure; this difference was found to be between the massage and control groups. This finding showed that neonates in the control group had more pain than the neonates in the massage group during the heel lancing procedure. In addition, oxygen saturation and heart rate values of the groups were found to reach the normal values rapidly after the procedure. This finding was considered to result from the short duration of the heel lancing procedure and fast physiological adaptation.

Infants, who cannot communicate verbally, use crying for communication. Crying is accepted as an important behavioural indicator for the assessment of pain in infants.[5,27] Abbasoğlu et al,[12] in their study that aimed to identify the effects of acupressure on pain during heel lancing in preterm neonates, found that duration of crying in the acupressure group was statistically significantly shorter. This study also found that acupressure and massage shortened the crying duration of the neonates. This finding indicated that acupressure and massage had effects on the crying duration in neonates who were applied heel lancing, and the crying duration was shorter in neonates who were applied acupressure and massage. Shorter crying duration was an indicator of the effects of acupressure and massage in decreasing pain.

Acupressure and massage stimulate serotonin release. Serotonin causes vasodilation through nitric oxide, and capillaries increase permeability.[5,12] Abbasoğlu et al[12] reported that the duration of heel lancing was statistically significantly shorter in neonates who were applied acupressure. İbrahim et al,[13] in their study that aimed to determine the effects of foot massage on pain during heel lancing in preterm neonates, found that the duration of heel lancing was statistically significant shorter in the foot massage group. This study found that heel lancing duration was shorter in the babies who were applied acupressure and massage. This finding indicated that acupressure and massage shortened the duration of heel lancing. The reason for shorter heel lancing in the acupressure and massage group was considered to be related to the vasodilation enhanced by serotonin and the effect of capillary permeability. The duration of heel lancing was statistically significantly shorter in the neonates who were applied massage. This finding indicated that massage was more effective in increasing vasodilatation and capillary permeability in comparison to acupressure. As a result, it is possible to say that massage shortened the duration of heel lancing according to acupressure.

4.1. Strengths of the study

One of the strongest aspects of this study is that it was designed as a randomized controlled study. Another strong side is that it is the first study that compared the effectiveness of acupressure and foot massage on pain caused by heel lancing. One more strong aspect is that heel lancing was performed for all the neonates in the same hours, in the same room, and by the same nurse. Finally, acupressure was performed by a researcher who was trained about this issue.

4.2. Limitations

The results of the study were limited by this study group population.

5. Conclusions

Acupressure and massage practices before the heel lancing procedure reduced pain, but the results were not statistically significantly different. Findings support that acupressure and massage was effective on the pain, oxygen saturations, heart rate, duration of crying and heel lancing procedure.

Declaration of Competing Interest

There is no conflict of interest in our article.

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