Original Article

The Effect of Swaddling on Pain, Vital Signs, and Crying Duration during Heel Lance in Newborns

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Abstract:

To determine the effect of swaddling on pain, vital signs, and crying duration during heel lance in the newborn. This was a randomized controlled study of 74 (control: 37, experiment: 37) newborns born between December 2013 and February 2014 at the Ministry of Health Bagcılar Training and Research Hospital. An information form, observation form, and Neonatal Infant Pain Scale were used as data collection tools. Data from the pain scores, peak heart rates, oxygen saturation, total crying time, and duration of the procedure were collected using a video camera. Newborns in the control group underwent routine heel lance, whereas newborns in the experimental group underwent routine heel lance while being swaddled by the researcher. The newborns' pain scores, peak heart rates, oxygen saturation values, and crying durations were evaluated using video recordings made before, during, and 1, 2, and 3 minutes after the procedure. Pain was assessed by a nurse and the researcher. No statistically significant difference was found in the characteristics of the two groups ($p > .05$). The mean pain scores of swaddled newborns during and after the procedure were lower than the nonswaddled newborns ($p < .05$). In addition, crying duration of swaddled newborns was found to be shorter than the nonswaddled newborns ($p < .05$). The average preprocedure peak heart rates of swaddled newborns were higher ($p < .05$); however, the difference was not significant during and after the procedure ($p > .05$). Although there was no significant difference in oxygen saturation values before and during the procedure ($p > .05$), oxygen saturation values of swaddled newborns were higher afterward ($p < .05$). For this study sample, swaddling was an effective nonpharmacologic method to help reduce pain and crying in an effort to soothe newborns. Although pharmacologic pain management is the gold standard, swaddling can be recommended as a complementary therapy for newborns during painful procedures. Swaddling is a quick and simple nonpharmacologic method that can be used by nurses to help reduce heel stick pain in newborns.

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INTRODUCTION

During the neonatal period, which covers the first 28 days after birth, newborns try to adapt themselves to the environment with biochemical and physiologic changes that involve all body systems (Pappas & Walker, 2010). During the adaptation process into the extrauterine environment, healthy newborns undergo medical interventions such as hepatitis B vaccination, vitamin K injection, blood sugar level monitoring, and screening for bilirubin or metabolic diseases (Joffe, Cohen, Bearden, & Welkom, 2009; Krishnan, 2013; Nicolet, Annequin, Biran, Mitanchez, & Tourniaire, 2010). The diagnostic heel lance is one of the most common medical interventions conducted in newborns (Cong, Ludington-Hoe, McCain, & Fu, 2009; Hummel & Puchalski, 2001; Stevens et al., 2003). Carbajal et al. (2008) conducted a study in France with newborns (N = 430) and reported that nearly one fifth of the medical interventions made for the newborns (19.8%) were composed of heel lance. It is known that heel lance causes increased pain, peak heart rates (PHRs), and blood pressure, along with decreased oxygen saturation (SpO_2) and crying (Gardner, Hagedorn, & Dickey, 2006; Krishnan, 2013; Prasopkittikun & Tilokskulchai, 2003).

Nonpharmacologic methods are valuable interventions to supplement pharmacologic management of pain (Czarnecki et al., 2011). Nonpharmacologic methods do not necessarily control pain but distract the newborn from the negative effects of the pain experience. Among the most commonly used nonpharmacologic techniques are those that reduce environmental stimuli and provide individualized developmental care, methods such as music therapy, breastfeeding, non-nutritive sucking, sucrose and sweet solutions, massage and touching, positioning, holding, containment, kangaroo care, and swaddling (Caglayan, 2011; Clifford, Stringer, Christensen, & Mountain, 2004; Cong et al., 2009; Efe, 2003; Karaayvaz, 2009; Krishnan, 2013; Nicolet et al., 2010; Yamada et al., 2008). In addition to this variety of methods, swaddling, which contains the newborn's limbs close to its trunk in a flexed position, as long as it is appropriate for the anatomic position of the newborns, is one of the most commonly used nonpharmacologic methods for attempting to decrease the negative effects of invasive interventions (Karp, 2008; Meek & Huertas, 2012; Mosiman & Pile, 2013).

There are many positive effects of swaddling for newborns. Swaddling reduces physiologic and behavioral stress, shortens the time to falling asleep, helps newborns to sleep uninterruptedly, prevents spontaneous waking, and shortens crying duration (Ramachandran & Dutta, 2013; van Sleuwen et al., 2006). Also, swaddling helps them spend less energy by enabling newborns to experience less stress during bathing, prevents hypothermia by assisting thermo regulation, positively affects neuromuscular and motor development, facilitates newborns' adaptation to the extrauterine environment, decreases sudden infant death syndrome (SIDS), and regulates peak heart rates and oxygen saturation by relieving pain caused by invasive interventions (Mosiman & Pile, 2013; Quraishy, Bowles, & Moore, 2013; van Sleuwen et al., 2007). In the limited number of studies in which swaddling was used during heel lance, it was reported that swaddling helped newborns to experience a significant decrease in pain, helped regulate peak heart rates and oxygen saturation, and shortened crying duration (Huang, Tung, Kuo, & Chang, 2004; Kacome, 1996; Morrow, Hidinger, & Faulk, 2010; Prasopkittikun & Tilokskulchai, 2003; Shu, Lee, Hayter, & Wang, 2014; Sinpru, Tilokskulchai, Vichitsukon, & Boonyarittipong, 2009; Srithong, 2002). Tantapong (2000) studied the effects of swaddling on pain responses to heel stick in 30 premature newborns (between 32 and 35 completed weeks of postconceptual age) in a quasiexperimental study. All newborns were observed twice (swaddled and unswaddled) in 2 consecutive days. The newborns were swaddled by a researcher, then swaddling and video recording were performed for 3 minutes before the procedure, during the procedure, and for 5 minutes after the procedure. The results revealed that swaddling significantly reduced the heart rate response to pain and pain scores of preterm newborns after heel stick.

An interprofessional team approach is required in pain management of newborns, and nurses are key members of this team (Anand & International Evidence-Based Group for Neonatal Pain, 2001; Hutchinson & Hall, 2005). The objective in pain management of newborns is to help newborns cope with pain and stress caused by clinical procedures, to reduce or to eliminate pain, and to prevent negative effects that can occur as a result of pain (Walden, 2010). Therefore, nurses should routinely and objectively assess newborns' pain using pain scales before and after medical interventions, and support newborns who experience pain with pharmacologic and nonpharmacologic methods (Gardner, Hines, & Dickey, 2011; Karaayvaz, 2009; Van Marter & Pryor, 2008).

MATERIAL AND METHODS

Study Aim and Design

This randomized controlled trial was undertaken to determine the effect of swaddling on pain, vital signs, and crying during heel lance for the Guthrie screening test (a screening test done on newborns for detection of congenital diseases) and to make contributions to the improvement of nursing care in newborns.

Sample

The population of the study was composed of newborns who were born and monitored at the Neonatal Unit of Gynecology and Obstetrics Clinics of Bagcılar Training and Research Hospital between December 2013 and February 2014. We calculated that a sample size of 74 patients would achieve 90% power to detect two-tailed significance level of .05 with $\alpha = .05$ and $\beta = .09$. The newborns were divided into two groups (experimental group and control group) and 37 patients were evaluated for each group. Randomization was performed using a computer program created by Jesse Rankin (n.d.). Numbers from 1-74 (N = 74) were randomly distributed by computer program to the two groups with no number repetition to determine which newborn would be in which group. The inclusion criteria were stable health status, no congenital anomalies, no analgesics or oxygen treatment, vitamin K injection and hepatitis B vaccination in the birth room but not to have had heel lance, born between 38 and 42 weeks, birth weight of 2,500-4,400 grams, and postnatal age of <1 week.

Data Collection Tools

Information Form. The information form, which was designed by the researcher in line with the study objectives, included multiple-choice and 15 open-ended questions about sex, birth date, gestational age, postnatal age, type of birth, birth weight, length, and head circumferences of the newborns; and age, educational status, and employment status of the mothers and fathers.

Observation Form. This form was used to record data about duration of heel lance and physiologic parameters such as PHR, oxygen saturation, and crying duration. Physiologic parameters were recorded under the titles of *1 minute before the procedure*, *During the procedure* (during the heel lance), and *1, 2*, and *3 minutes after the procedure*; *Total crying duration* and *Total duration* (of the procedure) were recorded in seconds.

Neonatal Infant Pain Scale. The Neonatal Infant Pain Scale (NIPS) was developed by Lawrence et al. in 1993 to assess behavioral responses and physiologic pain responses of preterm and full-term newborns and was adapted into Turkish by Akdovan in 1999. Lawrence et al. (1993) found the reliability coefficient of NIPS to be in the range of .92-.97. In addition, Akdovan (1999) reported the Cronbach's α value to be between .83 and .86. The scale comprised five behavioral indicators (facial expressions, cry, state of arousal, arms, legs) and one physiologic indicator (breathing patterns). With the exception of "cry," which had three possible score descriptors (0, 1, or 2), each behavioral indicator was scored with 0 or 1. The total score ranged between 0 and 7. High scores indicated higher levels of pain.

Pulse Oximeter. In the study, the Nellcor OxiMax N-560 (Medtronic, Minneapolis, MN) pulse oximeter was used. The SpO_2 measurement range and accuracy was between 1%-100% and 70%-100% $\pm$ 3 digits, respectively. The pulse rate range was between 20-250 beats per minute (bpm) $\pm$ 3 digits.

Camera. The video images of the study were recorded using a Sony Cyber-shot DSC-W150 (Sony Corp., Tokyo, Japan): Video resolution was 640 $\times$ 480 pixels and LCD screen was 2.7 inches with playback options.

Swaddling Cover. The cover used was 60 $\times$ 60 cm, cotton, and medium thickness. The newborns' own swaddling covers were preferred because of the risk of infection.

Data Collection

The researcher approached the parents and all parents agreed to participate in the study and signed informed consent forms. At the beginning of the data collection phase, a pretest was conducted with a total of eight newborns (four newborns from the experimental group and four from the control group). The applicability of the information form and experimental layout was tested during the pretest. These eight newborns were not included in the study sample. The implementation phase was then initiated.

After the legal guardians of the participant newborns who met the inclusion criteria were informed of the aim, type, and implementation procedure of the study, and how and where the data would be used, their written consents were obtained. The researcher used the information form to record data about the newborns and parents who agreed to participate in the study using the patients' files and information provided by the parents.

We ensured that the participant newborns were fed and had a clean diaper at least half an hour before the procedure. An oximeter was secured to the newborns before the intervention and peak heart rates and oxygen saturation values were obtained. The probe of the pulse oximeter was attached to the left foot of the newborns and was fixed so that it would remain in place.

For the control group, heel lance was performed with newborns in a "natural position." The natural position was the one taken by the newborns themselves while lying in a supine position on the procedure table.

No comforting or relaxation interventions were used during the heel lance procedure. After the procedure these newborns were immediately comforted. For the heel lance, only the newborns' lower clothes were removed.

For newborns in the experimental group, newborns were swaddled with legs in flexion and abduction without causing any movement restriction while lying in a supine position on the procedure table. During the heel lance procedure parents were not allowed to hold the newborns. After the procedure newborns were immediately comforted by their parents. Swaddling was performed 1 minute before heel lance and maintained for 3 minutes after the procedure. Swaddling was not too firm such that it would inhibit behavioral indicators (such as arm and leg movements) used in the pain assessment; neither was it too loose in order to protect the experiment's integrity. As with the newborns in the control group, only the newborns' lower clothes were taken off for the heel lance. Several drops of blood were taken from the heel and placed on a specially produced filter paper. The blood-drawing procedure was conducted by an experienced newborn nurse in one attempt and the same amount of blood was taken from each newborn. The same newborn nurse did all the blood draws. Standardization of blood drawing technique and environmental factors to which the newborns were exposed during the blood sampling were ensured for both groups: blood drawing site (lateral surface of the right heel), needle (21 gauge), antiseptic solution (70% of alcohol), temperature, light, and noise. During the data collection process parents could observe their newborns for both the experimental and control groups.

The interventions for both the experimental and control groups were videorecorded by the researcher, including the minute before the procedure was initiated, during the procedure, and for the 3 minutes after the procedure. Pain scores, peak heart rates, and oxygen saturation observed in the minute before the procedure, during the procedure, and 1, 2, and 3 minutes after the procedure were assessed using the video images. Pain assessment was scored by one consistent nurse in addition to the researcher using NIPS. Inter-rater reliability was not conducted. In addition, total crying time and duration of the procedure (seconds) were noted on the observation form, with reference to the video images.

Evaluation of Data

The data were analyzed using Statistical Package For Social Science Version 16.0 (SPSS Inc., Chicago, IL). Descriptive statistics were used to analyze group characteristics (mean, standard deviation). Mann-Whitney U test was used for the intergroup comparisons of parameters without normal distribution. Student t test was used to analyze the difference of peak heart rates and oxygen saturation in the newborns who were swaddled and not swaddled. Student t test was used for the intergroup comparisons of variables with normal distribution. Significance was accepted at $p < .05$ level.

Ethical Aspects of the Study

Before initiation of the study, ethics approval was received from the Ethics Board at Istanbul University, Cerrahpasa Medical Faculty, and the necessary official permissions from Bakirkoy-Istanbul General Directorate of Turkish Public Hospitals, under the authority of which Bagcilar Training and Research Hospital serves, in order to undertake the study. The legal guardians of the participant newborns who were included in the study were informed of the aim, type, and implementation procedure of the study and how and where the data would be used; their written informed consents were obtained.

RESULTS

A total of 54.1% of the experimental group and 48.6% of the control group were girls. For gestational age, 70.3% of the newborns in the experimental group and 56.8% of the control group were 39 weeks, and 54.1% of the experimental group and 67.6% of the control group were at the postnatal age of 24 hours. There were no significant differences between the experimental and control groups in terms of sex, gestational age, postnatal age, and type of birth, which meant that the groups were similar ($p > .05$).

When the experimental and control group were examined in terms of duration of heel lance, the procedure was completed in 70.74 ± 10.89 seconds in the experimental group and in 73.46 ± 12.90 seconds in the control group. There was no statistically significant difference between the groups, and they were similar to each other in duration of heel lance ($p > .05$).

When the mean pain scores of the groups before, during, and after the procedure were examined, there were no statistically significant differences between the experimental and control groups before the procedure ($p < .05$). The mean pain score of the experimental group during the procedure was 5.43 ± 1.19, whereas the mean pain score of the control group was $6.57 \pm .55$. The mean pain score of the experimental group 1, 2, and 3 minutes after the procedure was $1.56 \pm .82$, whereas the mean pain score of the control group at the same time points was 3.29 ± 1.47. The mean pain scores of the experimental group during

Table 1.
Comparison of Mean Pain Scores of Groups during and after the Procedure (N = 74)

NIPS Mean Scores		Experimental Group (n = 37)	Control Group (n = 37)		
Procedure	Min-Max	Mean ± SD		Test Values	p*
During the procedure	0-7	5.43 ± 1.19	6.57 ± .55	4.717	.001[†]
After the procedure[‡]	0-7	1.56 ± .82	3.29 ± 1.47	5.147	.001[†]

NIPS = Neonatal Infant Pain Scale; Min = minimum; Max = maximum; SD = standard deviation.
*Mann-Whitney *U* test.
[†]$p < .05$.
[‡]Mean scores of 1, 2, and 3 minutes after the procedure.

and after the procedure were lower compared with the control group, and the difference between them was statistically significant ($p = .001$) (Table 1).

When the mean PHR scores of the experimental and control group before, during, and after the procedure were examined, the mean PHR score of the experimental group before the procedure was 127.65 ± 14.17 bpm, whereas the mean PHR score of the control group was 121.57 ± 10.19 bpm. The mean PHR score of the experimental group before the procedure was higher than the control group, and the difference between the groups was statistically significant ($p = .038$). In the experimental group, swaddling was done just before the procedure. It may have caused newborns to move physically and therefore affected circulation by increasing PHR scores. The mean PHR score of the experimental group during the procedure was 133.62 ± 12.22 bpm, whereas the mean PHR score of the control group was 128.57 ± 11.10 bpm. The mean PHR score of the experimental group after the procedure was 141.37 ± 14.31 bpm, whereas mean PHR score of the control group was 145.85 ± 14.89 bpm. There were no statistically significant differences between the groups when the mean PHR scores during and after the procedure were compared ($p > .05$) (Table 2).

When the mean SpO_2 scores of the experimental and control group before, during, and after the procedure were examined, the mean SpO_2 score before the procedure was 98.67 ± 1.49% in the experimental group, whereas it was 98.94 ± 1.08% in the control group. The mean SpO_2 score of the experimental group during the procedure was 97.51 ± 2.17%, whereas it was 97.97 ± 1.61% in the control group. There were no statistically significant differences between the groups when mean SpO_2 scores before and during the procedure were compared ($p > .05$). The mean SpO_2 score of the experimental group after the procedure was 96.85 ± 1.88%, whereas it was 95.44 ± 2.36% in the control group. The mean SpO_2 scores of the experimental group were higher than the control group after the procedure, and the difference between the groups was statistically significant ($p = .006$) (Table 3).

When total crying durations of the experimental and control groups were examined, mean crying duration was 54.67 ± 26.59 seconds in the experimental group, whereas in the control group it was

Table 2.
Comparison of Mean Peak Heart Rates of Groups before, during, and after the Procedure (N = 74)

PHR (bpm)	Experimental Group (n = 37)	Control Group (n = 37)		
Procedure	Mean ± SD (bpm)		Test Value	p*
Before the procedure	127.65 ± 14.17	121.57 ± 10.19	2.119	.038[†]
During the procedure	133.62 ± 12.22	128.57 ± 11.10	1.861	.067
After the procedure[‡]	141.37 ± 14.31	145.85 ± 14.89	1.318	.192

PHR = peak heart rate; SD = standard deviation; bpm = beats per minute.
*Student *t* test.
[†]$p < .05$.
[‡]Mean scores 1, 2, and 3 minutes after the procedure.

Table 3.
Comparison of Mean Oxygen Saturation of the Groups before, during, and after the Procedure (N = 74)

SpO_2 (%) Procedure	Experimental Group (n = 37) Mean ± SD (%)	Control Group (n = 37) Mean ± SD (%)	Test Values	*p**
Before the procedure	98.67 ± 1.49	98.94 ± 1.08	.893	.375
During the procedure	97.51 ± 2.17	97.97 ± 1.61	1.036	.304
After the procedure†	96.85 ± 1.88	95.44 ± 2.36	2.850	.006‡

SD = standard deviation.
*Student *t* test.
†Mean scores 1, 2, and 3 minutes after the procedure.
‡$p < .05$.

81.67 ± 31.31 seconds. Crying duration in the experimental group was considerably shorter than in the control group ($p = .001$) (Table 4).

DISCUSSION

The womb is a compact environment with clear boundaries offering security. It can be mimicked through the containment offered during swaddling (Hall, 2008). The swaddling cover wraps the newborn and provides an environment that resembles the intrauterine environment. In addition, swaddling helps maintain a natural position that is compatible with the anatomic posture of the newborns and their levels of physiologic and behavioral stress reduce (Franco et al., 2005; Huang, Tung, Kuo, & Chang, 2004; Ramachandran & Dutta, 2013). Swaddling enables the newborn to move comfortably but also prevents excessive movements of the extremities, which helps newborns to become calm (Pillai Riddell et al., 2011; Sinpru, Tilokskulchai, Vichitsukon, & Boonyarittipong, 2009). Swaddling has been found to be a valuable and useful method in managing newborns' stress and pain responses during medical interventions such as heel lance (Mosiman & Pile, 2013). Shu et al. (2014) studied 75 newborns; each participant was randomly assigned to either the swaddling, heel-warming, or control group. For the heel-warming group they put water at 40°C in a thermal bag and applied the thermal bag against the puncture point for 5 minutes. Heel stick was performed immediately after removing the thermal bag. Both swaddling and heel warming decreased the pain response of newborns during heel stick. Huang et al. (2004) compared pain response to heel stick in 32 premature newborns of <37 weeks' gestational age between swaddling and containment in a study using a crossover experimental design. The initial order of containment or swaddling was assigned randomly. Each newborn underwent two heel sticks in different time periods and received the interventions of containment and swaddling one time each. Pain responses to heel stick under swaddling yielded lower scores than those under containment according to the total scores.

In the present study, the mean pain scores of newborns who were swaddled were statistically significantly lower (Table 1) during and after the procedure compared with those who were not swaddled, and the difference was statistically significant ($p < .05$). These results were important in the sense that the experimental group was comforted and had less pain during the procedure compared with controls.

Table 4.
Comparison of Mean Total Crying Duration of the Groups (N = 74)

Groups	Experimental Group (n = 37) Mean ± SD	Control Group (n = 37) Mean ± SD	Test Value	*p**
Crying duration (minutes)	54.67 ± 26.59	81.67 ± 31.31	3.736	.001†

SD = standard deviation.
*Mann-Whitney *U* test.
†$p < .05$.

Moreover, the mean pain scores of the swaddled newborns after the procedure were also statistically significantly reduced compared with controls. Other studies have reported that swaddled newborns have lower pain scores during invasive interventions, and the results of our study concur with these studies (Ho & Ho, 2012; Huang et al., 2004; Kacome, 1996; Morrow et al., 2010; Piyawattanasakul, 2004; Scaramuzzo et al., 2013; Shu et al., 2014; Sinpru et al., 2009; Srithong, 2002; Tantapong, 2000).

Swaddling should enable the newborn to move comfortably and prevent excessive movement of the newborn's limbs (Pillai Riddell et al., 2011). Swaddling that limits the excessive movements of newborns may minimize the physical response to the pain. This intervention contributes to the reduction of responses of the sympathetic nerve system by decreasing the number of stimuli transmitted to the spinal cord, thalamus, and cortex. PHR, blood pressure, and respiratory rates are reduced with swaddling, and SpO_2 rate is increased (Sinpru et al., 2009). In a study conducted by Sinpru et al. (2009) to compare the effect of a clinical nursing practice guideline for swaddling and swaddling with using standard nursing care on pain during heel stick in 60 newborns between 37 and 42 weeks' gestational age and 48 hours' postnatal age. Newborns in the control group received standard nursing care–based swaddling. Each newborn was wrapped in a 1 meter $\times$ 1 meter piece of cloth. All newborns in the study group were swaddled according to the clinical nursing practice guidelines using two pieces of cloth of both sizes, 1 meter $\times$ 1 meter and 1 meter $\times$ 1 foot. It was determined that the newborns swaddled according to the clinical nursing practice guideline had lower mean heart rates and lower mean pain scores. Also they observed that the newborns in the clinical nursing practice guideline group were in a calm state longer and entered a sleep state more easily.

In the present study, the mean PHR scores of the swaddled newborns were higher than those not swaddled before the procedure, and the difference between the groups was statistically significant ($p < .05$) (Table 2). When the mean PHR scores of the groups obtained during and after the procedure were compared, no statistically significant differences existed between the groups ($p > .05$). When these findings were considered, we were of the opinion that swaddling, which was done just before the procedure, may have caused newborns to move physically and therefore affected circulation by increasing PHR scores. Swaddling did not affect PHR scores during the procedure, and higher PHR scores may have been caused by crying and pain during the procedure. In addition, swaddling was not effective in reducing the newborns' PHR scores during and after the procedure. PHR findings of the present study were similar to the findings of Srithong (2002) and Shu et al. (2014). They found that the PHR increase did not significantly differ between the groups in their studies. Srithong (2002) compared pain response to heel stick in premature newborns of 32-35 weeks' gestational age between swaddling and pacifier. There were no significant differences in mean heart rate between groups. Our findings were dissimilar to the findings of Kacome (1996), Tantapong (2000), Huang et al. (2004), Piyawattanasakul (2004), Sinpru et al. (2009), and Ho and Ho (2012). The results for these studies indicated that swaddled newborns had lower mean heart rates. Ho and Ho (2012) investigated the effect of facilitated swaddling to control procedural pain. A total of 54 premature newborns of 30-36 6/7 weeks' gestational age from a neonatal intensive care unit were randomly assigned to facilitated swaddling and control groups. Swaddling reduced mean heart rates variability at all measured time points during heel stick procedure (preprocedure and during, immediately after, and 2, 4, 6, and 8 minutes after heel stick).

In the present study, SpO_2 scores of the swaddled newborns were higher than controls after the procedure, and the difference between the groups was statistically significant ($p < .05$) (Table 3). Swaddling before and during the procedure did not affect SpO_2 scores of the newborns; however, SpO_2 scores after the procedure increased in swaddled newborns. Newborns who were swaddled had better respiratory functions after heel lance. Shu et al. (2014) reported a similar result, that swaddled newborns' SpO_2 scores values were higher than control and heel-warming groups after the heel stick.

Crying is the only innate communication method of newborns through which they manage to express their needs (Gardner & Goldson, 2011). The most evident and observable behavioral response shown against painful interventions of newborns is crying. With crying caused by pain, severity and duration of pain may be detected (Uyan, Bilgen, Topuzoğlu, Akman, & Özek, 2008). Swaddling contributes to reactivation and self-regulation of newborns by preventing excessive movements of the extremities. Thus, the crying duration shortens in the swaddled newborns (Cowan, 2012; Meek & Huertas, 2012; Ohgi, Akiyama, Arisawa, & Shigemori, 2004; van Sleuwen et al., 2006).

In the present study, the mean total crying duration of swaddled newborns was shorter than those not swaddled, and the difference between the groups was statistically significant ($p < .05$) (Table 4). The result was important in the sense that newborns who were swaddled during heel lance became calm sooner—even if they cried—and their crying duration was shorter. As a result, it was understood that newborns whose video images were recorded between the time of before heel lance and the time of the third minute after heel lance calmed down sooner and cried less whey they were swaddled. As reported in the present study and other studies, swaddling and other nonpharmacologic practices performed during feeding, medical interventions, or stressful interventions help newborns with self-soothing methods and they consequently have fewer behavioral and physiologic stresses. Thus, the crying duration shortens in newborns who have fewer behavioral and physiological stresses.

Limitations

This study has some limitations. A major limitation of this study was that the researcher approached all parents to invite their newborns' participation in the study. The parents had only 20 minutes to decide whether to allow their newborn to be included in the study. Another limitation of the study was the researcher and one consistent nurse did all newborn pain assessments without assessing inter-rater reliability. This is a weakness for the study's validity.

CONCLUSION AND RECOMMENDATIONS

For this study sample, swaddling was effective at reducing mean pain scores during and after heel lance; was partly effective at increasing SpO_2 scores and shortening crying duration during the procedure; but was not effective at decreasing PHR scores. To conclude, swaddling may be recommended in clinical practice in order to manage the negative effects of invasive interventions such as heel lance in newborns. Pain management nurses need effective pain relief methods that are easily applicable and do not take much time. Swaddling is a quick and easy nonpharmacologic method that can be used by nurses to reduce pain of heel stick in newborns. For future studies, it may be recommended that swaddling should be performed much longer before medical interventions are initiated (e.g., 5 minutes before medical interventions are started) so that PHR and SpO_2 scores are not negatively affected by physical movements. In addition, studies should be done that incorporate the use of swaddling during other neonatal procedures such as immunizations. Future research should be conducted to compare swaddling with other nonpharmacologic strategies such as sucrose administration.

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