

Efficacy of Heel Warming on Pain Response to Heel Stick in Neonates

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ABSTRACT

Introduction: Heel prick is one of the commonest procedures carried out in the hospitalised newborns. Pain is a subjective experience for which the neonates, infants and children respond with behavioural reactions. Applying hot pack to the skin surface causes proximal blood vessels to dilate due to the raised temperature which may decrease the pain perception in neonates. We intended to study the effect of heel warming during heel prick in perception of pain in neonates.

Method: An experimental study was conducted among neonates admitted in paediatric wards of BPKIHS. Total 92 participants undergoing heel prick/stick were selected by consecutive sampling technique and allocated randomly to experimental group and control group. Warmer was applied to the heel of the baby for three to five minutes which provided the baby's heel with the warmth of 38°C to 40°C prior to heel stick in experimental group only. Newborn's pain level was assessed in both experimental and control group through The Neonatal Infant Pain Scale (NIPS). Mann Whitney test was used to compare means of pain score between experimental and control groups.

Results: The mean pain score among experimental group was 1.39 and in control group was 2.20. Experimental group showed significantly lower pain ($p < 0.001$) compared to the control group. Application of warmth before heel stick caused reduction in pain.

Conclusions: The findings suggest that heat application prior to heel stick is effective in reducing pain in newborns.

Keywords: Heel stick; Heat application; Neonates; Pain



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INTRODUCTION

A newborn infant or neonate is a child under 28 days of age. During this period, the child is at the highest risk of dying.¹ More than 50% of under 5 child deaths occur in the neonatal period.² Neonatal mortality is 19.9 per 1000 live births in our country.² Healthy normal newborns experience pain as part of routine newborn care. However, pain becomes an inevitable part of neonates who require intensive care. This pain comes in the form of invasive procedures such as blood sampling, vaccinations, vitamin K injections, heel prick etc. Sick or preterm neonates require increased medical care, which results in a greater exposure to painful procedures.

Heel blood sampling is the most frequently performed invasive procedure in the newborn period. It is one of the painful procedures to newborn. It is acknowledged to be painful, and recent research has focused on ways of obtaining samples more humanely.³ Several studies have documented the effectiveness of non-pharmacological analgesia, such as containment, positioning, and non-nutritive sucking, warming, kangaroo holding in neonates during painful procedures.⁴

Pre-warming the heel to increase blood flow is recommended as part of heel preparation but is not widely practiced. If effective, warming should benefit infants by reducing the amount of squeezing required and the need for repeat punctures, so that the procedure is completed more quickly.³ Applying a heat pack to the skin surface causes proximal blood vessels to dilate. Vasodilatation may reduce the squeezing pressure on the heel of neonates, and drawing blood becomes easy, which may mitigate the pain perception in neonates when the heel stick is performed.^{5,6}

At full term, density of nociceptive nerve endings in the newborn is similar to that of an adult but descending inhibitory tracts, which act to suppress the transmission of noxious stimuli, are not fully functional at term. Thus, newborns are more sensitive to pain compared with older children.⁷ Providing warmth to newborn infants during a painful procedure decreases the crying and grimacing that accompanies the pain of a vaccination.⁸ This warming treatment is natural,

easy, and performed better than the currently used analgesic treatments of sucrose taste or pacifier suckling.⁹ Heel warming can contribute to control minor procedural pain in neonates.¹⁰ The study of Zahed PY et al.¹¹ and Shepherd AJ et al.⁶ showed decrease of pain in newborns following application of heat while doing invasive procedure. Similarly in the studies by Gray et al.⁹ and Shu et al.¹², it was shown that significant reduction of pain was there when heat packs have been applied before heel sticks in neonatal care units.

The objective was to find out the effectiveness of heel warming on pain response of neonates while heel prick. Thus an experimental study was carried out. Here we have studied the efficacy of heel warming on pain response to heel stick in neonates using pain assessment tool which is multidimensional and assesses pain in terms of behavioural and physiological indicators as neonates cannot self-report.

METHODS

This was a prospective study done in Biseshowsor Parsad Koirala Institute of Health Sciences (BPKIHS) Dharan, Nepal. The study was conducted among the neonates of Neonatal Ward, Paediatric Ward, Maternal and Child Health (MCH) Ward and Postnatal Ward of BPKIHS Department of Paediatrics. The study was done from August 2017 to July 2019. The ethical approval for the study was taken from Institutional Review Committee (IRC) BPKIHS, Dharan.

Neonatal Infant Pain Scale (NIPS) was used to assess the pain score. NIPS is a behavioural assessment tool for measurement of pain in preterm and full term neonates.¹³ The total sample size was 92. Neonates who were admitted in Paediatric, Postnatal, MCH wards and Neonatal Ward of our institute, who were undergoing heel prick and whose parents gave the consent, were included in the study. We excluded the neonates with known neuromuscular disorder, who had altered sensorium, who had fever, who had received analgesic within last six hours, who were under phototherapy, radiant warmer and bedside heater and whose parents did not consent. The neonates included in the study were randomly allocated into two groups i.e. control group and experimental group by tossing a coin. Each experimental and

control group consisted of 46 samples. Before heel pricking procedure, written or verbal informed consent was taken from the mother after explaining the procedure as well as objectives of the study. Neonate's mother was also explained regarding the pain expressed by child according to NIPS. The warmer (electro thermal water bag) was charged for three minutes. It was disconnected from the charging point after three minutes. Following the heating, the temperature was measured with the help of a thermometer. Temperature was maintained between 38°C to 40°C. The instrument was tested for any leakage, then the temperature of the instrument was reassured by feeling the heat by the researcher herself and the staff who performed heel prick also felt for it. Mother or the neonate's guardian was also allowed to feel for the warmth of the instrument. It was applied to the heel of the baby of experimental group for three to five minutes which provided the baby's heel with the warmth of 38°C to 40°C. After five minutes, the warmer was removed and the on duty ward sister performed heel prick procedure to collect the blood sample as required. Alcohol (spirit swab) was used before the heel puncture. For the control group, no application of heat was done before heel prick procedure. The neonate's pain level was assessed in both experimental and control group by using NIPS by author herself. Heart rate and oxygen saturation of neonates were monitored and data was collected. All the collected data were checked for completeness and were entered into statistical

Table 1. Socio-demographic characteristics of neonates

Charact eristics	Category	Experimental group (n = 46)		Control group (n = 46)		p value
		n	%	n	%	
Gender	Male	17	37.0	31	67.4	0.36
	Female	29	63.0	15	32.6	
Ethnicity	Dalit	1	2.2	4	8.7	0.39
	Janajati	26	56.5	18	39.1	
	Madhesi	6	13.0	7	15.2	
	Muslim	1	2.2	1	2.2	
	Brahmin / Chhetri	11	23.9	13	28.3	
	Others	1	2.2	3	6.5	
Age (days)	Mean ± SD	1.17 ± 0.383		3.52 ± 3.371		0.31

package SPSS for windows, version 20.0. Data were analysed using descriptive and inferential statistics.

RESULTS

There were altogether 115 hospitalised newborns that were assessed as eligible for the study. Five neonates were excluded due to febrile condition; five of them were excluded because they were under bedside heater and three of them cried due to pain from the beginning of the procedure and therefore were excluded. After excluding, 92 cases were included in the study. Coin was tossed to select the first case (either experimental or control), thereafter, the cases were assigned to each experimental and control group alternatively.

Table 1 shows that there were 48 (52.1%) male and 44 (47.9%) female neonates included in the study. Most of the newborns included in our study were Janajatis (56.5%) in regards to their ethnicity. Similarly in routine warming group also most of the subjects were also from ethnicity Janajatis. Followed by Janajatis were Brahmin / Chhetri and Madhesi respectively in regards to ethnicity. The mean age with standard deviation of the

Table 2. Background characteristics of neonates

Charact eristic	Category	Experimental group (n = 46)		Control group (n = 46)		P value
		N	%	N	%	
Type of delivery	Normal vaginal delivery	20	43.5	26	56.5	0.19
	Caesarean section	24	52.2	19	41.3	
	Instrument al delivery	2	4.3	1	2.2	
Birth order	First	32	69.6	32	69.6	0.49
	Second	9	19.6	13	28.3	
	Third	5	10.9	1	2.2	
Birth weight (grams)	Less than 2500	9	19.6	10	21.7	0.32
	2500 - 3900	26	56.5	30	65.2	
	More than 3900	11	23.9	6	13.0	
		3160.65 ± 692.25		3031.41 ± 588.98		

Table 3. Comparison of Heart rate, oxygen saturation and temperature before and after heel stick

Characteristics	Category	Experimental group (n = 46)	Routine heel warming group (n = 46)	P value
Heart rate (per minute)	Before	134.67 ± 7.75	130.54 ± 6.81	0.008
	After	135.30 ± 7.51	135.35 ± 7.25	0.978
Oxygen saturation	Before	96.26 ± 2.13	96.46 ± 1.66	0.625
	After	95.89 ± 2.25	94.07 ± 2.17	< 0.001
Temperature	Before	97.37 ± 0.415	97.42 ± 0.445	0.596
	After	97.37 ± 0.415	97.44 ± 0.395	0.413

participants was 1.17 ± 0.383 days in the experimental group and 3.52 ± 3.371 days in the control group and ranging from 1 to 28 days. Here the study groups i.e. experimental and control group did not significantly differ by gender, ethnicity, and age.

Table 2 shows that most of the newborn were born via normal vaginal delivery (50%) followed by cesarean section (46.7%) and instrumental delivery (3.3%) in both the groups. Regarding the birth order, most of the neonates (69.6%) were the first babies in both experimental and routine warming groups. In case of birth weight most of the newborns (60.9%) were within the weight ranges of 2500 grams to 3900 grams. There was no significant difference in the obstetric related variables like type of delivery, birth order and birth weight between the experimental and control group.

Table 3 shows that there was no significant difference in heart rate before and after heel stick between two groups. Similarly we compared the oxygen saturation before and after heel stick in the experimental and routine warming group. The results of the t-test reveals that there was significant difference in oxygen saturation after heel stick between experimental and control group (< 0.001). The result also shows that oxygen saturation significantly reduced in the routine heel warming group than the experimental group. There was no

Table 4. Comparison of pain score between experimental and routine heel warming group

Characteristics	Experimental group (n = 46)		Routine warming group (n = 46)		P value
	Mean ± SD	Mean rank	Mean ± SD	Mean rank	
Pain score (NIPS)	1.39 ± 0.57	25.91	2.20 ± 0.51	67.09	< 0.001

significant difference in temperature before and after heel stick between experimental and control group.

Table 4 showed that there was significant difference in mean pain score between experimental and control group (0.001). The null hypothesis was not accepted. Thus, it can be concluded that newborns in experimental group (heel warming neonates) had lower pain than in control group (non heel warming neonates).

DISCUSSION

Heel prick or stick is one of the commonest medical procedures performed in hospitalised neonates to collect blood sample. Pain related to heel stick may cause anxiety to neonates as well as their parents and should be managed appropriately. This pain comes in the form of invasive procedures such as blood sampling, vaccinations, vitamin K injections etc. Sick or preterm neonates require increased medical care, which results in a greater exposure to painful procedures.

Heel warming can reduce pain. Providing warmth to newborn infants during a painful procedure decreases the crying and grimacing that accompanies the pain of a vaccination.¹⁴ Applying a heat pack to the skin surface causes proximal blood vessels to dilate. Vasodilatation may reduce the squeezing pressure on the heel of neonates, because drawing blood becomes easy, which may mitigate the pain perception in neonates when the heel stick is performed.¹⁵

We had included a total of 92 newborns undergoing heel stick in our study. Forty six newborns in each experimental group and control group were randomly allocated. Study groups i.e. experimental and control group did not significantly differ by,

gender, age, ethnicity and other background characteristics of neonate. Among the total participants, more than half were females in the experimental group (63.0%) and more than half of neonates were males in the control group (67.4%).

Ethnic group of the participants was divided into six categories. In both control and case groups, majority of the participants were Janajatis. This may be due to the fact that the study was conducted in Dharan, Sunsari, and Eastern part of Nepal where Rai and Limbu are the largest ethnic population and comprising the Janajatis.

No significant differences in delivery method, birth order, and birth weight were observed between the groups, indicating that the groups were homogeneous. This is consistent with the study by Shu et al.¹² and Stevens et al.¹⁶ In our study difference in mean heart rate before and after the procedure varied by less value in the experimental group whereas there was variation in the mean heart rate before and after the procedure in the control group which was higher value in comparison to experimental group. Thus, it signified that in control group neonates felt more pain. However, it was found that the heart rate increase did not significantly differ between the groups in this study. This finding was consistent with that reported by Stevens et al.¹⁶ who considered heart rate as an indicator of pain reactivity.

The mean heart rate before heel stick in experimental group was 134 beats per minute. It is similar to the study done by Gray et al.⁹ With infant warmers universal in hospitals today, this warming treatment is natural, easy and performed better than the currently used pharmacological methods. Even though it is easily accessible, still in our set up, it is lacking. An increased HR and NIPS score and decreased oxygen saturation indicated higher pain reactivity. After the heel stick test, NIPS mean score was significantly higher in the control (2.20) than in the experimental group (1.39) in the present study. It is similar to the study done by Shuet et al.¹² where heart rate (HR), oxygen saturation, pain

scores (Neonatal Infant Pain Scale) were measured at baseline and following the heel stick test. Regarding the oxygen saturation in the present study, the results of the t-test revealed that there was significant difference in oxygen saturation after heel stick between two groups. The results showed that oxygen saturation significantly reduced in the routine warming group than the experimental group, indicating more pain in the control group. In our study, after the painful stimulus, a significant reduction in oxygen saturation and an increase in heart rate and NIPS scores were detected within the groups ($p < 0.001$) and this finding is consistent with the study done by Gokulu et al.¹⁴

Our study has the strength of having both the experimental and control groups homogenous in context of socio-demographic characteristics and background characteristics. However, since our study was done in a single centre of Eastern Nepal, our study findings may not be generalised to the entire country. There was significant difference in mean rank of pain score in experimental group compared to the control group that is 25.91 and 67.09 respectively. Thus, heel warming before heel stick is effective in reducing pain in neonates. However, our results need to be further analysed and compared with larger, multi centric studies in the future.

CONCLUSIONS

The present study concluded that heat application prior to heel stick is effective in reducing pain in newborns as mean rank of pain score among experimental group was less in comparison to control group. Hence, heel warming can reduce the pain response of neonates during the heel stick procedure and heel warming could be a very apt, simple, effective method to decrease the pain response of neonates during heel stick.

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