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Effect of skin contact between mother and child in pain relief of full-term newborns during heel blood collection

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Summary

Objectives: The aim was to investigate the effect of skin contact between mother and child in pain relief of full-term newborns during heel blood collection. *Materials and Methods:* The authors randomly divided 40 full-term newborns into two groups. In the experimental group, the newborn received kangaroo care from the mother before, during, and after the 20-minute heel blood collection. In the control group, the heel blood collection was performed under conventional conditions. The authors compared the two groups' heart rate, oxygen saturation, facial expressions of pain, and duration of crying. *Results:* The two groups had no statistically significant difference in terms of gender, birth weight, mode of delivery, and gestational age ($p > 0.05$). In the seven time periods during the puncture after ten seconds from the beginning and ten seconds after the end, the neonatal heart rates of the two groups changed and statistically significant differences were observed in the duration of heel blood collection, interaction and group factors, as well as in oxygen saturation ($p < 0.01$). *Conclusions:* During heel blood collection, skin contact between the mother and child can relieve pain, reduce changes in heart rate, improve neonatal heel blood oxygen saturation, and enhance the emotional communication between the mother and child.

Key words: Skin-to-skin care; Kangaroo care; Pain; Sufficient with pricks.

Introduction

Skin-to-skin care, also called the 'kangaroo care,' is practiced on newborns, usually preterm infants, wherein the infant is held close to the mother's chest. The mother and the infant are bonded skin-to-skin and chest-to-chest, which provides warmth and security for the infant [1]. Given that infants cannot verbally express their pain and that their underdeveloped neural system makes them insensitive to pain stimulation-induced ache and stress, their feelings of pain have not been discussed much in previous studies [2-4]. Pain does not only cause neonatal hyperalgesia, high oxygen consumption, high metabolism, acid electrolyte imbalance and other complications among infants, but can also affect their nervous system's structure and function which results in a series of long-term changes in their behaviour, such as inattentiveness, hyperactivity, and other disorders. Pain can also cause short-term negative reactions among infants. Pain stimulations, such as heel lancing [5], nasogastric tube placement, and mechanical ventilation cause significant physiological reactions like accelerated heart rate [6], decreased oxygen saturation [7], increased blood pressure (BP) [8], and intracranial pressure (ICP) [9], which changes the cerebral blood flow that results to periodical hypoxemia, fluctuation in BP levels, reperfusion injuries, and venous congestion. The infant responds to these stimulations via behavioural reactions such as crying, changing of facial expressions (wrinkling of brows, squeezing of eyes, and etching deep lines around their noses), moaning, and changing of body posture and movement. The most acknowledged among these responses are the infant's crying and changing of facial expressions [10]. An infant who experiences pain at an early stage undergoes long-term behavioural changes afterwards. For example, the male infant who is circumcised without any anaesthesia becomes more sensitive to pain stimulation, such as when he receives a vaccine shot after four to six months [11]. Staying in the Neonatal Intensive Care Unit (NICU) is also found to significantly increase the infant's sensitivity to pain. Twenty-eight-week preterm infants who have stayed in the NICU for four weeks have developed a stronger sensitivity to pain as compared to 32-week preterm infants. Such sensitivity to pain is directly related to the frequency of invasive medical procedures. Compared to the full-term infants, infants with very low birth weight who have undergone prolonged hospitalization or repetitive invasive medical procedures develop somatic symptoms in 4.5 years, along with attention deficit hyperactivity disorder (ADHD), learning difficulties, cognitive and behavioural dysfunctions, and poor adaptability [12]. Pain control can be categorized into two groups, namely, drug and non-drug. Non-drug pain relief methods, such as skin contact, touching, feeding of syrup and other non-nutritive sucking, are commonly used by mothers in fear of the drugs' side effects to their children. Chen and Liu [13] found that infants can perceive pain and respond via significant physiological reactions. The field of healthcare does not think highly of pain

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among infants, which lead to ineffective pain relief measures for infants who undergo diagnostic and therapeutic operations. Such topic has been largely ignored as doctors cannot completely determine safe medicine dosages for infants and certain non-drug pain relief methods lack systematic research. Therefore, the infants' pain must be recognized, prevented, and quantified at an early stage to effectively intervene with their health and to maintain their physiological and psychological stabilities. Non-drug methods can sufficiently reduce pain among infants. This study aimed to investigate the effects of skin-to-skin care in the heart rate, transcutaneous oxygen saturation, facial expressions, physical activity, and sound performance of infants, to evaluate the feasibility of this pain relief method, and to provide a reasonable theory for the mitigation and prevention of neonatal pain.

Table 1. — *Comparison of general information between control group and study group (X±S).*

General Information	Study group (N=40)	Control group (N=20)	Intervention Group (N=20)	t value	*p* value
Birth weight (g)		3,740.00± 298.90	3,337.00± 409.10	-1.170	0.249
Gestational age (week)		39.36±0.63	39.30±0.94	-0.216	0.830
Gender					
Male	17	7	10		
Female	23	13	10	2.333	0.062
Type of delivery					
Vaginal	7	4	3		
Cesarean	33	16	17	0.406	0.419

Materials and Methods

Subjects

Between April 2010 and December 2010, the authors selected 40 infants, 15 male and 25 female, from the present hospital's obstetrics ward as their study subjects. Every subject underwent heel lancing 72 hours after their birth. The infants were selected based on the following criteria: 1) weighed greater than 2.5 kg, 2) obtained a ten-point Apgar Score five minutes after their birth, 3) gestational age greater than 37 weeks, and 4) the mother must sign Informed Consent Agreements and voluntarily participate in this research. Neonates were excluded from the study based on the following criteria: 1) if they cried 15 seconds before the heel lancing, 2) if they had received sedatives and analgesics within 24 hours, 3) if they had received surgery; 4) if they had congenital anomalies, 5) if they had infections that required antibiotics, 6) if they had experienced abortive heel lancing beforehand, and 7) if their mothers had a cold, fever or gastroenteral illness. This study was conducted in accordance with the declaration of Helsinki and with approval from the Ethics Committee of Wuxi Maternity and Child Health Hospital Affiliated to Nanjing Medical University. Written informed consent was obtained from all participants.

Grouping method

Random number table method was used to divide ten infants into groups at a single time. The selected infants were assigned a number ranging from 0 to 9 based on their birth order. Those assigned with numbers 0 to 4 were placed in the intervention group, whereas those assigned with 5 to 9 were placed in the control group. This selection method was repeated until both groups had 20 infants.

Intervention method

Control group: After the infants were routinely bathed, they were wrapped up in clothes to reduce body temperature loss. They remained wrapped up during and one minute after the heel lancing.

Intervention group: 20 minutes before the heel lancing, the authors approached the mothers on their bedsides and helped them prepare for the kangaroo care. The room temperature was set between 26ºC and 28ºC, the doors and windows were closed, the mothers were lifted head-side of bed, and the infants were handed to them still wrapped up in clothes or covers. Afterwards, certain pieces of clothing were removed to reveal large portions of the infants' skins. The infants were then held close to their mothers' naked chests. The authors assisted the mothers to place their infants in a vertical or frog position skin-to-skin to their chests. They also instructed the mothers on how to hold their infants' buttocks with one hand and the other hand over their backs to avoid the infants from slipping and to enhance the skin-to-skin contact. The nurse administered heel lancing after 15 minutes. The mother and the infant would remain in their positions during and one minute after the heel lancing.

Physiological measures

The research process was divided into three phases, namely, ten seconds before the heel lancing, during the heel lancing (from puncturing the heel until a sufficient amount of blood had been drawn), and the recovery phase (ten seconds after the heel lancing). A multifunction monitor was used to record the infant's heart rate and oxygen saturation at three different phases. The researcher would record the infant's heart rate and oxygen saturation every ten seconds before the heel lancing to the end of the recovery phase.

Pain score

Douleur Aiguë Nouveau-né (DAN) Scale [14] was used to quantify the infant's pain. The infant's facial expression was scored between 0 to 4 points, the body movements between 0 to 3 points, and crying between 0 to 3 points, which totalled to 10 points. The score reflected the intensity of the pain among the selected infants. The researcher also recorded the duration of the infant's facial expressions and crying.

Statistical analysis

SPSS v15.0 software was used to process the data and to express all information in mean ± SD (standard deviation). The measurement data, such as birth weight, were expressed in mean and SD. The numerical data, such as gender or type of delivery, were expressed in frequency and percentage and were analyzed via T test. The duration of the facial expression and crying were analyzed by the Wilcoxon rank-sum test (Mann-Whitney U test). The heart rate and oxygen saturation rate were analyzed via Repeated Measure ANOVA.

Results

General condition

The intervention and control groups had no statistically significant difference in their birth weight, gestational age, sex, and type of delivery ($p > 0.05$) (Table 1).

Table 2. — *Comparison of infantile heart rate at different time spot between groups (bpm).*

Item	Before HL	Heel lance (HL)						After HL	F value		
		10 s	20 s	30 s	40 s	50 s	60 s		Time	Interaction	Grouping
Intervention group	118.05± 6.09	124.95± 6.32	132.30± 4.93	138.30± 3.39	145.40± 4.76	151.60± 4.49	156.65± 5.26	134.80± 6.18	369.69*	5.390*	153.282*
Control group	120.60± 5.62	136.70± 5.17	144.80± 5.00	154.65± 5.58	162.65± 5.58	170.35± 4.37	174.50± 2.84	144.80± 12.15			

* $p < 0.01$

Table 3. — *Comparison of infantile oxygen saturation rate at different time spot between groups (%).*

Item	Before HL	Heel lance (HL)						After HL	F value		
		10 s	20 s	30 s	40 s	50 s	60 s		Time	Interaction	Grouping
Intervention group	98.35± 0.75	88.00± 4.08	84.75± 3.39	86.15± 6.22	87.70± 7.89	82.15± 10.10	78.20± 5.82	98.10± 0.85	71.377*	2.358*	9.535*
Control group	97.40± 1.39	84.95± 9.88	81.50± 9.61	78.95± 7.13	78.50± 8.61	76.15± 8.99	75.05± 10.76	93.30± 4.00			

* $p < 0.05$

Table 4. — *Comparison of pain index between groups.*

Items	Average rank-sum of control group	Average rank-sum of intervention group	*p* value
Pain facial expression time (s)	21.75	9.25	0.041
Crying time (s)	22.28	10.72	0.033

Infantile heart rate

Table 2 compares the two groups' neonatal heart rates at different time periods. The neonatal heart rates were stable before the blood collection. The intervention group's change in heart rate was less than that of the control group before the blood collection and the recovery stage. Repeated measurement of variance (F = 369.695, $p = 0.000$) indicated a statistically significant difference in the two groups' heart rates at different time points. The time * grouping (F = 5.390, $p = 0.000$) showed a statistically significant difference in the interaction time and packet.

Infantile oxygen saturation rate

Table 3 compares the oxygen saturation of the infants at different time points. During the blood collection, the neonatal oxygen saturation decreased in varying degrees among the two groups, in which the intervention group's blood oxygen saturation remained at approximately 80% before recovering to 98.10% after ten seconds from the blood collection. Moreover, the intervention group experienced less reductions in oxygen saturation compared to the control group at each time point.

Pain index

Table 4 shows a statistically significant difference ($p < 0.01$) between the two groups' pain indicators.

Discussion

Kangaroo care is a non-drug therapy, which has been identified by few Chinese studies to have an intervention effect on pain [15]. By examining the infant's heart rate, transcutaneous oxygen saturation, and acute pain during a randomized, controlled trial, the present authors observed that the skin contact between the mother and child had an intervention effect on neonatal pain. Heel lancing is the most common medical procedure for neonatal pain [16]. Pain stimulation leads to a series of physiological responses, which cause both short- and long-term effects. A proper and acute assessment of infantile pain, along with a positive and effective intervention, can eradicate its harmful effects [17]. By holding them close to their mothers' chests, the infants have 82% less chances to cry and 65% less chances to make facial expressions during the heel lancing [18]. The present experiment shows that the infants in the intervention group had cried (41.90 ± 8.93 s) and had made facial expressions (71.15 ± 16.45 s) for a shorter time than those in the control group. The intervention group also has a DAN score (5.85 ± 0.98) that is lower than that of the control group. A statistically significant difference between the two groups was observed ($p < 0.01$). Kangaroo care reduces the infants' responses to pain by providing them a safe and cosy environment. The mothers' comfort and encouragement has a major role in the infants' resistance to pain stimulation [19]. Table 2 shows that before heel lancing, the control and intervention groups had no statistically significant difference on heart rate ($p > 0.05$), which indicates the absence of pain stimulation among infants before the heel lancing. However, the heart rate changes among the two groups during the seven ten-second intervals ten and 60 seconds after the heel lancing. Based on time, interaction, and grouping factors, there is a statistical significance between the two groups ($p < 0.01$). Given that time equals to F = 369.695, $p = 0.000$,

Table 2 shows the statistical significance of the two groups' heart rates at different time periods. During the heel lancing, both groups' heart rates accelerates (Time * Grouping: F = 5.390, $p = 0.000$) which indicates the statistical significance of time and grouping interaction. The heart beat acceleration rate of the intervention group is much lower than that of the control group. Skin-to-skin contact between the mother and infant reduces the changes in the infant's heart rate during the pain stimulation. Other studies also found that while administering kangaroo care, the mothers' respiration, heart beat, and blood flow all mimicked their condition when the infants are still in their uterus, which enhances the security of the infants [20]. Infants become more secure when their mothers hold them close to their chests, touch them, and let them feel their heartbeat [21]. The present data shows that after the heel lancing, the heart rate of the intervention group became lower than 160 bpm. Therefore, the kangaroo care is proven to sufficiently support the infantile ventricular relaxation and to reduce the negative effects to the infant's cardiac output and heart rate acceleration.

During kangaroo care, the mother's temperature is quickly transferred to the newborns. After an hour of kangaroo care, the newborns' body temperature reaches the normal level and stays within that range [22]. Body temperature is the major factor to the infant's blood oxygen saturation rate. There is no statistical significance between the control and intervention groups' blood oxygen saturation rate before the heel lancing. However, a statistically significant difference ($p < 0.05$) was observed between the two groups' blood oxygen saturation rate during the seven ten-second intervals ten and 60 seconds after the heel lancing. During the heel lancing, the blood oxygen saturation rate of both groups dropped significantly, which indicates that acute pain lowers the infant's blood oxygen saturation rate. Table 3 shows Time: F = 71.377, $p = 0.000$. The two groups' blood oxygen saturation rates had a statistical significance at different time spots. During the four ten-second intervals 30 to 60 seconds after the heel lancing, the blood oxygen saturation rate of the control group became lower than 80%. However, 60 seconds after the heel lancing, the blood oxygen saturation rate of the intervention group became lower than 80%. Given that Time * Grouping: F = 2.358, $p = 0.024$, the time and grouping interaction shows a statistical significance. Although both groups' blood oxygen saturation rates dropped during the heel lancing, the blood oxygen saturation rate of the intervention group remained around 80%. During the last ten seconds of the heel lancing, the infantile blood oxygen saturation rate recovered to 98.10%. During most time spots, the infantile blood oxygen saturation rate of the intervention group was lower than that of the control group. All of these findings indicate that skin contact between the mother and infant significantly reduces the duration of pain stimulation. Therefore, this pain relief method prevents and ultimately reduces the infantile hypoxemia. When the pain stimulation is unavoidable during the infantile period, kangaroo care can be administered to reduce the hypoxemia that is caused by pain and improve the development of the infants' systems [23]. The present study proved that the skin contact between the mother and infant reduces the effects of pain stimulation for full-term infants during heel lancing. Unfortunately, this research was conducted at a small-sample scale. In actual practice, the inaccuracy of many factors, such as environmental factors, crying of infants, and probe position of life monitor, had different effects on experimental data collection, which ultimately reduced the sample size. The present authors hope to continue this research at a much broader population. After improving their surveillance method, they hope to find an effective way to reduce the effects of pain stimulation to infants, to help develop their personalities and intelligence at an early stage, and to improve their social adaptability.

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References

[1] Abrowski G.A.: "Skin-to-skin contact: giving birth back to mothers and babies". *Nuts Womens Health*, 2007, *11*, 64.

[2] Merskey H., Albe-Fessard D.G., Boniea J.J., Carmon A., Dubner R., Kerr F.W.L. *et al*.: "Pain terms: A list with definitions and notes on usage: Recommended by the IASP subcommittee on taxonomy". *Pain*, 1979, *6*, 249.

[3] Fitzgerald M., Melntosh N.: "Pain and analgesiain the newbom". *Aieh Dis. Child*., 1999, *64*, 441.

[4] Howard R.F.: "Current status of pain management in children". *JAMA*, 2003, *290*, 2464.

[5] Sellam G., Cignacco E.L., Craig K.D., Engberg S.: "Contextual factors influencing pain response to heelstick procedures in preterm infants: what do we know? A systematic review". *Eur. J. Pain*, 2011, *15*, 661.e1.

[6] Sabourdin N., Arnaout M., Louvet N., Guye M.L., Piana F., Constant I.: "Pain monitoring in anesthetized children: first assessment of skin conductance and analgesia-nociception index at different infusion rates of remifentanil". *Paediatr Anaesth*, 2013, *23*, 149.

[7] Neves J.F., Monteiro G.A., Almeida J.R., Brun A., Cazarin N., Sant'anna R.S., Duarte E.S.: "Association of fentanyl or sufentanil an 0.5% isobaric bupivacaine in spinal anesthesia: a comparative study". *Rev. Bras. Anestesiol*., 2002, *52*, 535.

[8] Giannantonio C., Papacci P., Ciarniello R., Tesfagabir M.G., Purcaro V., Cota F., *et al*.: "Chest physiotherapy in preterm infants with lung diseases". *Ital. J. Pediatr*, 2010, *36*, 65.

[9] Tamura A., Sonoo M., Hoshino S., Iwanami T., Shimada H., Miki T., Shimizu T.: "Stimulus duration and pain in nerve conduction studies". *Muscle Nerve*, 2013, *47*, 12.

[10] Stevens B.J.: "Pain in infants. In McCaffery M, Pasero CC, eds". Pain Clinical Manual. St. Louis: Mosby, 2001.

[11] Taddio A., Katz J., Ilersich A.L., Koren G.: "Effect of neonatal circumcision on pain response during subsequent routine vaccination". *Lancet*, 1997, *349*, 599.

[12] Feudtner C., Kang T.I., Hexem K.R., Friedrichsdorf S.J., Osenga K., Siden H., *et al*.: "Pediatric palliative care patients: a prospective multicenter cohort study". *Pediatrics*, 2011, *127*, 1094.

[13] Chen W.H., Liu Y.Q.: "Effects of non-nutritive sucking and K2 glucose sucking on alleviating thepain of neonatalinfants". *Journal of Nursing Administration*, 2010, *10*, 355.
[14] Wang X.D., Luo X.Q.: "Pain Management in Infants". *Int. J. Nurs*., 2006, *25*, 677.
[15] Huang Y.L., Ye Y.Q., Huang D.M., Wu Q.Z., Shi Y.Q., Wang W.Q. *et al*.: "Study on the influencing factors of pain in newborn infants". *Chinese Journal of Nursing*, 2009, *44*, 709.
[16] Barker D., Rutter N.: "Exposure to invasive procedures in neonatal intensive care unit admissions". *Arch. Dis. Child. Fetal Neonatal Med*., 1995, *72*, F47.
[17] Franck L.S., Oulton K., Bruce E.: "Parental involvement in neonatal pain management: an empirical and conceptual update". *J. Nurs. Scholarsh*., 2012, *44*, 45.
[18] Gray L., Watt L., Blass E.M.: "Skin-to-skin contact is analgesic in healthy newborns". *Pediatrics*, 2000, *105*, 14.
[19] Marín Gabriel M.A., Llana Martín I., López Escobar A., Fernández Villalba E., Romero Blanco I., Touza Pol P.: "Randomized controlled trial of early skin-to-skin contact: effects on the mother and the new born". *Acta Paediatr*, 2010, *99*, 1630.
[20] Anderson G.C.: "The mother and her newborn: mutual caregivers". *J. Gynecological and Neonatal Nursing*, 1977, *10*, 50.
[21] Moore E.R., Anderson G.C., Bergman N., Dowswell T.: "Early skin-to-skin contact for mothers and their healthy newborn infants". *Cochrane Database Syst. Rev*., 2012, *5*, CD003519.
[22] Svensson K.E., Velandia M.I., Matthiesen A.S., Welles-Nyström B.L., Widström A.M.: "Effects of mother-infant skin-to-skin contact on severe latch-on problems in older infants: a randomized trial". *Int. Breastfeed. J*., 2013, *8*, 1.
[23] Gizzo S., Di Gangi S., Saccardi C., Patrelli T.S., Paccagnella G., Sansone L., *et al*.: "Epidural analgesia during labor: impact on delivery outcome, neonatal well-being, and early breastfeeding". *Breastfeed. Med*., 2012, *7*, 262.

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