J Pediatr Res 2025;12(1):14-21
DOI: 10.4274/jpr.galenos.2025.35545

Original Article

A Non-pharmacological Application to Reduce Neonatal Pain During Lumbar Puncture Procedure in Neonatal Intensive Care: Placing a Pillow on the Abdomen

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ABSTRACT

Aim: Lumbar puncture is one of the most common painful procedures which newborn babies encounter during neonatal intensive care follow-up. It is important to control pain during this procedure. The aim of this study was to show the effects of using a pillow placed in the abdominal area as a non-pharmacological application in order to relieve neonatal pain during the lumbar puncture procedure.

Materials and Methods: Forty newborn babies who were monitored in the neonatal intensive care unit of our hospital and received an indication for lumbar puncture were included in this study. Babies who underwent lumbar puncture were randomly selected and divided into two groups. Lumbar puncture was performed on 20 babies in group 1 by placing a pillow which we had prepared in the abdominal area. In addition, lumbar puncture was performed on 20 babies in group 2 without placing a pillow in the abdominal area during lumbar puncture. The vital signs and the neonatal infants pain scale pain scores of the two groups were compared.

Results: Forty newborn babies were included in this study. Their average week of birth was 30.61±4.32 (24-38) weeks and their average birth weight was 1.531.25±951.34 (640-3.675) grams. Of the babies, 26 (65%) were male and 14 (35%) were female. When the pillow we prepared was placed on the abdominal area during lumbar puncture, the pain score was lower, although this difference was not significant.

Conclusion: Placing a pillow on the abdominal area during lumbar puncture, which is one of the painful procedures in neonatal intensive care, can be applied as a nonpharmacological method.

Keywords: Newborn, pain, lumbar puncture, pillow

Introduction

Newborn babies in neonatal intensive care units (NICUs) are exposed to repeated painful interventions. If appropriate approaches are not taken to alleviate pain in babies exposed to these interventions, permanent neurological and behavioral problems may occur in their later life. Not providing adequate pain control to those babies who are monitored for a long time in the NICU increases this risk. These negative consequences of pain may be caused by the undesirable effects of drugs such as analgesics and

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Received: 02.10.2024 **Accepted:** 14.01.2025 **Epub:** 06.03.2025 **Publication Date:** 17.03.2025

Cite this article as: Tanrıverdi S, Köse Yaman H, Kahraman S, Kublay E. A Non-pharmacological application to reduce neonatal pain during lumbar puncture procedure in neonatal intensive care: Placing a pillow on the abdomen. J Pediatr Res. 2025;12(1):14-21

sedatives used for pharmacological intervention, as well as failures to prevent pain (1).

The main purposes of evaluating the pain response are; to detect the painful condition of the baby, to determine their pain levels and to reveal any needs for intervention. Thus, evaluating their pain responses aims to avoid inadequate or unnecessary treatment (2). There are more than forty methods for assessing pain responses in newborns. Of these, the neonatal infant pain scale (NIPS) is an assessment scale developed for newborns which behaviorally evaluates their responses to pain during invasive procedures (3).

Pain management is very important as it has been shown that pain in the newborn has permanent consequences. There are two types of treatment for pain: Pharmacological and non-pharmacological. However, the important thing is to reduce and eliminate painful stimuli as much as possible rather than treating them. Non-pharmacological methods, such as breastfeeding and breast milk, pacifiers, skin-to-skin contact, positioning the baby, touch, massage, and providing painless sensory stimulation with sound and smell can effectively reduce discomfort and pain in preterm and term babies (4). Positioning and keeping babies in a midline flexion posture during painful interventions may make it easier for them to calm down. Loosely swaddling the baby during interventions has been found to be effective on physiological and behavioral pain responses (5).

One of the most common painful procedures which newborn babies encounter during NICU follow-up is lumbar puncture. It is important to control pain during this procedure.

There are studies on the appropriate positioning of newborn babies to reduce pain during lumbar puncture (6); however, there is no study in the literature to date which investigates the effects on pain of placing a pillow on the abdominal region during lumbar puncture in newborn babies. In a study conducted in 2009 on the use of a pillow in the abdominal region during lumbar puncture in children with cancer aged 2-18, although not statistically significant, there was less pain and greater satisfaction in those children using a pillow (7).

Placing a pillow on the abdomen during a lumbar puncture provides lumbar flexion, allows the paravertebral muscles to relax, and improves the patient's position during the lumbar puncture, allowing them to maintain a proper position and relax. The aim of this study was to show the effects of applying a pillow to the abdominal area as a non-pharmacological application to relieve neonatal pain during a lumbar puncture procedure.

Materials and Methods

Forty newborn babies who were monitored in the NICU of our hospital and who received an indication for lumbar puncture were included in this study. This study was approved by the Manisa Celal Bayar University Faculty of Medicine Health Sciences Ethics Committee (approval no.: 20.478.486/1400, date: 15/06/2022).

The inclusion criteria for this study were babies whose gestational week was over 28 weeks who required lumbar puncture (excluding those who had started antibiotics due to symptoms of sepsis or in cases of growth in blood culture or in cases where there was no response to antibiotic treatment) (8) were included in this study. Informed consent forms were obtained from those families who agreed to participate in this study.

Babies with congenital vertebral anomalies, major congenital anomalies, babies born asphyxiated or babies whose general condition was not suitable for lumbar puncture (babies with no signs of sepsis for whom antibiotic treatment was started after birth, babies with thrombocytopenia, babies with damaged skin integrity in the area to be punctured and babies with a meningomyelocele sac) were not included in this study.

The babies were randomized by a sealed envelope method and divided into two groups according to the method of lumbar puncture.

Lumbar puncture was performed on the babies in group 1 by placing a pillow which we had prepared in the abdominal area. Lumbar puncture was performed on the babies in group 2 without placing a pillow in the abdominal area during lumbar puncture. The pillows used were made separately for each baby by the same nurse, using bonnet material filled with cotton.

The bonnet and cotton used to prepare the pillow were disposable. Pillows were prepared in sizes appropriate for the baby's weight and abdominal circumference. The lumbar puncture procedure was performed in accordance with the rules of the aseptic technique (Figures 1, 2).

Each baby was monitored during lumbar puncture. Their heart rate, respiratory rate, perfusion index, and blood pressure were measured and recorded before (one minute before), during, and after (one minute after) the lumbar puncture. The NIPS pain scale was used by the same nurse before, during, and after the lumbar puncture (9). The NIPS pain score was calculated according to facial expression, crying, breathing pattern, arm movement, leg movement, and alertness. NIPS pain scores >3 indicate the presence of pain (Table I).

Figure 1. Lumbar puncture was performed on the babies by placing a pillow which we had prepared in the abdominal area. The pillows used were made separately for each baby by the same nurse, using bonnet material filled with cotton. The bonnet and cotton used to prepare the pillow were disposable. Pillows were prepared in sizes appropriate for the baby's weight and abdominal circumference

Figure 2. Lumbar puncture was performed on the babies by placing a pillow in the abdominal area. The lumbar puncture procedure was performed in accordance with the rules of the aseptic technique

Table I. NIPS

Parameters	**0 point**	**1 point**	**2 point**
Facial expression	Relaxed	Contracted	-
Cry	Absent	Mumbling	Vigorous
Breathing	Relaxed	Different than basal	-
Arms	Relaxed	Flexed/stretched	-
Legs	Relaxed	Flexed/stretched	-
Alertness	Sleeping/calm	Uncomfortable	-
>3 points: Pain			
NIPS: Neonatal infant pain scale			

The vital signs and pain scores of the two groups were compared.

Statistical Analysis

Statistical analysis was performed with SPSS 25. The Mann-Whitney U test was used to compare continuous variables, and the chi-square test was used to compare categorical variables. Statistical significance was determined as $p<0.05$.

Results

When the demographic characteristics of the babies included in this study were examined, their average gestational age was 30.61±4.32 (24-38) weeks, their average birth weight was 1.531.25±951.34 (640-3.675) grams, their average birth length was 39.50±7.72 (29.0-52.5) cm, and their average head circumference was 27.89±4.02 (23-36) cm. Of the babies, 26 (65%) were male and 14 (35%) were female.

The demographic and antenatal characteristics of group 1, in which a pillow was placed during lumbar puncture, and group 2, in which a pillow was not placed during lumbar puncture, are shown in Table II. There was no significant difference between the demographic and antenatal characteristics of the groups (Table II).

No significant difference was detected between respiratory support and nutrition during lumbar puncture of groups 1 and 2. The clinical features are shown in Table III.

In the comparison between groups 1 and 2, no significant difference was found in the vital signs (heart rate, respiratory rate, blood pressure) or NIPS pain scores before, during and after lumbar puncture; although no significance was detected, the heart rate, respiratory rate, blood pressure and NIPS pain scores of group 1 were lower than group 2 ($p>0.05$) (Table IV).

Table II. Comparison of demographic characteristics of patients in groups 1 and 2

	Group 1 (n=20)	**Group 2 (n=20)**	**p value**
Gestational age (weeks)	30.10±3.95 (25-36)	30.90±4.99 (24-38)	0.696
Birth weight (g)	1357.50±617.41 (680-2875)	1705.29±1209 (640-3975)	0.429
Birth length (cm)	39.40±6.43 (30-50)	39.61±9.36 (29.0-52.5)	0.955
Birth head circumference (cm)	27.65±3.19 (23-34)	28.16±4.97 (23-36)	0.789
Gender, n -Female -Male	 8 12	 6 14	0.639
Mode of birth, C/S, n	20	18	0.305
Apgar 1st	7 (6-9)	8 (6-10)	0.327
Apgar 5th	8 (8-10)	9 (8-10)	0.137
Maternal age	27.40±3.20 (19-44)	25.77±5.71 (23-32)	0.450
Number of maternal pregnancies, n	3 (1-5)	2 (1-4)	0.278
Number of maternal births, n	2 (0-3)	1 (0-3)	0.271

g: Gram, cm: Centimeter, C/S: Cesarean section

Table III. Comparison of clinical findings of patients in groups 1 and 2

	Group 1 (n=20)	**Group 2 (n=20)**	**p value**
The day the lumbar puncture was made	40.80±26.51 (6-67)	29.50±37.71 (5-119)	0.448
Sepsis, n -Clinic -Proven	 4 16	 10 10	0.307
Meningitis, n	0	0	1
Respiratory support when lumbar puncture is performed, n -Room air -Non-invasive ventilation -Intubate, mechanical ventilation	 10 8 2	 12 6 2	0.981

Table III. Continued			
	Group 1 (n=20)	**Group 2 (n=20)**	**p value**
Nutrition when lumbar puncture is performed, n -Total parenteral nutrion -Total parenteral nutrion+enteral -Enteral -Oral	 6 4 6 4	 4 8 6 2	 0.717
Hospital stay (day)	84.33±40.97 (18-141)	75.80±54.44 (14-162)	0.707
Mortality, n	0	2	0.330

Table IV. Babies in groups 1 and 2's comparison of vital signs and pain scores before, during and after LP			
Lumbar puncture before	**Group 1 (n=20)**	**Group 2 (n=20)**	**p value**
HR (min)	146.40±14.40 (121-172)	153±8.93 (142-168)	0.234
RR (min)	55.40±1.89 (52-58)	57.40±2.11 (56-62)	0.059
PI	0.91±0.30 (0.1-1.1)	0.69±0.25 (0.1-1)	0.095
SBP (mmHg)	68.77±6.97 (57-84)	75.11±12.74 8 (61-94)	0.209
DBP (mmHg)	41.33±9.88 (32-60)	47.44±11.69 (31-64)	0.249
MBP (mmHg)	52.00±7.64 (43-68)	57.88±9.84 (41-69)	0.176
NIPS pain score	0	0.30±0.94 (0-3)	0.331
Lumbar puncture during			
HR (min)	167.10±18.81 (143-212)	168.20±8.13 (156-178)	0.867
RR (min)	57.20±3.67 (52-64)	60.40±4.69 (54-68)	0.107
PI	0.83±0.36 (0.26-1.40)	0.67±0.35 (0.08-1.20)	0.320
SBP (mmHg)	74.87±12.36 (54-90)	85.00±17.00 (68-120)	0.195
DBP (mmHg)	49.25±16.48 (24-74)	49.50±10.70 (39-71)	0.972
MBP (mmHg)	56.62±9.70 (43-76)	64.12±16.50 (41-90)	0.287
NIPS pain score	1.90±1.44 (0-5)	2.40±1.34 (1-5)	0.435
Lumbar puncture after			
HR (min)	155.60±21.15 (108-181)	160.20±19.34 (117-184)	0.618
RR (min)	56.80±4.54 (52-68)	59.20±3.91 (54-66)	0.221
PI	0.97±0.41 (0.48-1.80)	0.66±0.22 (0.4-1)	0.054
SBP (mmHg)	77.11±10.81 (60-91)	77.88±7.57 (67-89)	0.862
DBP (mmHg)	46.11±5.84 (38-56)	47±5.72 (38-53)	0.749
MBP (mmHg)	55.11±4.67 (46-59)	58.22±8.01 (45-70)	0.329
NIPS pain score	1.10±1.28 (0-4)	1.30±0.94 (0-3)	0.697

LP: Lumbar puncture, HR: Heart rate, RR: Respiratory rate, PI: Perfusion index, SBP: Systolic blood, DBP: Diastolic blood pressure, MBP: Mean blood pressure, NIPS: Neonatal infant pain scale

Babies who have a pillow placed on their abdomen during a lumbar puncture tend to be more relaxed before, during, and after lumbar puncture.

Discussion

The purposes of evaluating pain response are; to detect painful conditions of the baby, to determine pain levels and to reveal any needs for intervention. Thus, the aim is to avoid inadequate or unnecessary treatment. Within the scope of the neonatal pain control program of the American Academy of Pediatrics and the Canadian Pediatric Association, both routinely and at regular intervals, it is recommended to evaluate both before and after painful interventions (2). More objective evaluation can be achieved

by using structured methods in the evaluation of pain in newborns. These structured methods are versatile, therefore, it is preferable to include several physiological, behavioral or other variables. Painful interventions cause physiological changes such as an increase in heart rate, blood pressure, respiratory rate and a decrease in oxygen saturation, changes in respiratory rhythm, and changes in skin color (3). Along with these changes, there are changes in crying, facial expressions (frowning, squinting, nasolabial wrinkles and opening of the mouth), hand and body movements, and muscle tone (10). Although the changes observed in preterm babies are parallel to those in term babies, they may be more subtle (11).

The "premature infant pain profile (PIPP)", the "crying, requires oxygen saturation, increased vital signs, expression, sleeplessness", the "NIPS", and the "neonatal pain agitation and sedation scale (N-PASS)'' are used in the evaluation of pain responses in newborns. There are many methods available, such as N-PASS and the "Neonatal Facing Coding System" (2).

NIPS, which was developed by Lawrence et al. (12) in 1993, is a method which is suitable and frequently used to evaluate procedural pain in premature and term babies.

One of the most common painful procedures which newborn babies encounter during their stay in the NICU is lumbar puncture. It is important to control pain during lumbar puncture.

Pain management is very important as it has been shown that pain in the newborn has permanent consequences. There are two types of treatment for pain: Pharmacological and non-pharmacological. However, the important thing is to reduce and eliminate painful stimuli as much as possible rather than treating them. Non-pharmacological methods, such as breastfeeding and breast milk, pacifiers, skin-to-skin contact, positioning the baby, touch, massage, and providing painless sensory stimulation with sound and smell, can effectively reduce discomfort and pain in preterm and term babies (4). Positioning and keeping babies in a midline flexion posture during painful interventions may make it easier for them to calm down. Loosely swaddling the baby during interventions has been found to be effective on physiological and behavioral pain responses (5).

It has been stated that changing their position provides significant comfort to newborns. Change of position is a practice which prevents the development of pain, reduces acute pain, increases blood circulation, and prevents muscle contraction and spasm (13). During painful procedures, keeping babies in a midline flexion posture and loose enough to allow them to put their hands to their mouths may make it easier for them to calm themselves (1). In the study by Çağlayan and Balcı (14) in which they evaluated pain scores during blood collection from the heel of 41 preterm newborns born under the 37th gestational week in both routine and fetal positions (facilitated tucking), those babies in the fetal position had lower pain scores. In the study conducted by Lopez et al. (15) with 42 preterm babies, the PIPP pain score was evaluated in order to determine the effectiveness of the fetal position on relieving pain during venous intervention, and the pain scores of the positioned group were found to be significantly lower than the control group.

Many studies have shown the benefits of non-pharmacological treatments, such as sucrose and kangaroo care, in reducing pain scores in newborns during mildly painful routine procedures (16). Skin-to-skin contact with the mother is an effective method of pain treatment during simple interventions (17). When glucose or sucrose is applied together with kangaroo care, it reduces neonatal pain related to minor procedures more than either of them alone (18). Other effective methods include vanilla scent and manual swaddling by the parent during interventions (19). It has been observed that sensory stimulation provided by massage, talking, eye contact, and/or perfume smell, when used together with glucose, provides more effective analgesia than using a pacifier with glucose (20). It was determined that using pacifiers, rocking and swaddling were the most effective methods in reducing pain (21). There are studies showing that visual stimulation consisting of touch, massage, talking, listening to music and in-utero sounds, and moving toys may have pain-reducing effects (22).

Before lumbar puncture procedure, non-drug pain control methods (such as sugary solutions, pacifiers, and breast milk) which are appropriate to the patient's clinic should be applied. If there is enough time, local anesthetic cream can be applied. There are also centers where subcutaneous lidocaine injection is performed (23). Before starting a painful procedure such as lumber puncture, the baby should be made to feel comfortable and safe, and disturbing sounds and lights should be avoided. In accordance with this, the baby can be fixed with a loose cover or by gently giving the baby's hand or foot a flexion posture (1).

The most common positions used to perform lumbar puncture are the lateral decubitus and sitting position. However, it is uncertain which position best improves patient outcomes. Most study participants were term

newborns (24). A study found that lumbar puncture performed in the prone position was safe, effective, and comfortable in premature and low birth weight infants (6). In a questionnaire study to evaluate the lumbar puncture procedure in neonates in Spanish hospitals examining the materials used and sedation-analgesia, the most commonly used measures were topical anesthetics (90.3%) and sucrose (82.2%). Other non-pharmacological interventions (aspiration, comfort measures, breastfeeding) were used at a rate of 7% (25).

In our study, it was thought that the baby would feel safer and more comfortable in the flexion position and with a pillow placed on the baby's abdomen before the lumbar puncture procedure. It was observed that the baby's vital signs, heart rate, respiratory rate, blood pressure and pain score, before, during and after lumbar puncture, were lower in the group in which the pillow was placed compared to the group in which the pillow was not placed, although not significantly. This practice has not been seen among the non-pharmacological methods used to reduce pain in neonatal lumbar puncture attempts in the literature. There is no study on this subject to date. There is sufficient evidence to support the use of non-pharmacological interventions, particularly breastfeeding, sweet-tasting solutions, and skin contact, as primary strategies for pain management during common needle puncture procedures. Music therapy, sensory saturation, rocking and holding, swaddling, appropriate positioning, pacifier retention, facilitated compression, and nonnutritive sucking are recommended for acute pain management in infants (5). Further research comparing individual non-pharmacological pain management interventions and their combined effects for commonly performed painful procedures in NICUs, such as lumbar puncture, is needed.

Conclusion

As a result of this study, placing a pillow on the baby's abdomen during lumbar puncture may be considered as a non-pharmacological intervention which can be used to alleviate the infant's pain response.

Ethics

Ethics Committee Approval: This study was approved by the Manisa Celal Bayar University Faculty of Medicine Health Sciences Ethics Committee (approval no.: 20.478.486/1400, date: 15/06/2022).

Informed Consent: Informed consent forms were obtained from those families who agreed to participate in this study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: S.T., H.K.Y., S.K., E.K., Concept: S.T., H.K.Y., S.K., E.K., Design: S.T., H.K.Y., S.K., E.K., Data Collection or Processing: S.T., H.K.Y., S.K., E.K., Analysis or Interpretation: S.T., Literature Search: S.T., H.K.Y., Writing: S.T., H.K.Y.

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

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

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