The effects of flexed (fetal tucking) and extended (free body) postures on the daily sleep quantity of hospitalized premature infants: A randomized clinical trial

Leila Valizadeh, Golnar Ghahremani, Manizheh Mostafa Gharehbaghi[1], Mohammad Asghari Jafarabadi[2]
Department of Pediatric Nursing, Nursing and Midwifery Faculty, Tabriz University of Medical Sciences, [1]Department of Pediatric, Medicine Faculty, Tabriz University of Medical Sciences, [2]Road Traffic Injury Research Center, Faculty of Health, Tabriz University of Medical Sciences, Tabriz, Iran

Background: Proper sleep is essential for the development of premature infants. Infants, during hospitalization, might suffer from inappropriate postures and insufficient sleep hours. To compare the daily sleep quantities of premature infants in flexed (facilitated fetal tucking) posture and extended (free body) posture. This study is a randomized clinical trial which was conducted in neonatal ward of Al-Zahra Teaching Hospital of Tabriz, Iran, 2015. Thirty-two premature infants with the age range of 33–36 weeks were selected for the study. **Materials and Methods:** Every infant was studied for 4 days in a sequential format. Every infant was studied for 4 days and in a 12-h period every day (8 a.m–8 p.m). Each day, an infant was randomly put in one of the four statuses, namely, free body posture in the supine position, free body posture in the lateral position, facilitated fetal tucking in the supine position and facilitated fetal tucking in the lateral position. Films were recorded in the 12-h period (8 a.m–8 p.m). SPSS Software (version 13) was used for data analysis. **Results:** The results showed that about the main effect of posture on sleep variable, there was a statistically significant difference ($P = 0.003$). In addition, about the main effect of position on sleep variable; there was a statistically significant difference ($P = 0.002$). Meanwhile, there was no significant interaction effect between the posture and position for the daily sleep duration ($P = 0.746$). Daily sleep duration of the infants in flexed (facilitated fetal tucking) posture and lateral position is longer than that of the infants in extended (free body) posture and supine position. **Conclusion:** Daily sleep duration in the infants experiencing flexed posture and lateral position at rest is longer. Moreover, it decreases wakefulness time of the premature infants.

Key words: Facilitated fetal tucking, lateral position, posture, premature infants, supine position

How to cite this article: Valizadeh L, Ghahremani G, Gharehbaghi MM, Asghari Jafarabadi M. The effects of flexed (fetal tucking) and extended (free body) postures on the daily sleep quantity of hospitalized premature infants: A randomized clinical trial. J Res Med Sci 2016;21:132.

INTRODUCTION

Almost 10% of all labors are premature labors[1] and nearly 12.9 million babies are born premature in the world.[2] When a baby is born prematurely, the nervous system is functionally immature.[3] The full maturation of the central nervous system in premature infants directly depends on the organization of sleep and wakefulness states.[4,5] Sleep is essential to brain development and maturation in infants. Infants require extensive sleep for further development of the neurosensory systems; structural development of the hippocampus, pons, brainstem, and midbrain and optimizing physical growth.[6]

When an infant is born premature, he/she must be hospitalized in the Neonatal Intensive Care Unit (NICU) or neonatal ward to improve the function of the central nervous system and other body systems. However, the problem is that many of these hospitalized infants are usually exposed to invasive procedures which cause stress and stimulation,

Access this article online
Quick Response Code:
Website: www.jmsjournal.net
DOI: 10.4103/1735-1995.196606

Address for correspondence: Ms. Golnar Ghahremani, Department of Pediatric Nursing, Faculty of Nursing and Midwifery, Tabriz University of Medical Sciences, Shariati St., Tabriz, East Azerbaijan Province, Iran. E-mail: golnar.gahramani@yahoo.com
Received: 08-02-2016; **Revised:** 28-05-2016; **Accepted:** 02-09-2016

and this is inconsistent with the development of the neurosensory system.[7]

To define sleep, it is the time to relax associated with consciousness loss and the reduction of physical activity.[8] Gestational age (GA) of 32 weeks could be a turning point for the maturation of the sleep-wake states. Hence, the quality of sleep and wakefulness in premature infants under 32 weeks is limited due to a premature brain.[9] Hence, the quality of sleep and wakefulness in infants is improved after 32 weeks[10] and can make it easy to study the sleep.

Hospitalized infants employ the changes in sleep and wakefulness modes as a strategy to adapt themselves to the stressful environmental conditions.[11] With the development and organization of sleep and wakefulness modes, baby health is improved and the infant responds appropriately to the caretakers and surrounding environment.[12] Through the improvement of sleeping conditions, the infant's energy is maintained while protein synthesis and the release of growth hormone increase. Moreover, androgen stimulations essential for sensory neural development are activated.[13]

Broadly speaking, achieving a sustainable sleep-wake patterns and transitions between them is an important developmental issue for the infants in their 1st week of life.[14,15]

It should be noted that the infants born preterm are deprived of uterine flexed in curved during the third trimester of pregnancy. This trimester improves the development of physiologic flexion, a position characterized by shoulder flexion, scapular protraction, hip and knee flexion, and posterior pelvic tilt. The late stages of pregnancy also encourage midline orientation.[16] This position prepares the infant for later function, supports neurodevelopment, and promotes self-soothing. As preterm infants are deprived of this critical experience, in addition to having neurological immaturity, they often lack adequate muscle tone and strength at birth. This usually causes them to maintain their bodies in extended positions. This suboptimal position can impact development and can inhibit self-regulation.[17]

Facilitated fetal tucking is a technique to support the infant and causes the infant to control his/her body until it gets autoregulated.[18] In facilitated fetal tucking, the infants' hands and feet are in the middle line while the infant is laying on one side or he/she is laying on back or on the abdomen.[19,20] To minimize the consequences of premature births, caretakers should try to develop flexion position through the application of new methods.[21] Blanket swaddling, which is using soft cloth rolls for making some borders around the infant, and using nest around the infant are some methods used in NICUs to make a pleasant position for the infant.[17]

The Neonatal Individualized Developmental Care and Assessment Program (NIDCAP) is a comprehensive program proposed by Als. NIDCAP has been recommended as a helpful way for caregivers to perform highly individualized care.[22]

NIDCAP intervention supports the infants through increasing stability and reducing the stress and agitation by (1) improving the environment with decreasing noise and light in the room and with using covers over incubators, (2) using appropriate positioning aides support flexed positions such as nests, blanket swaddling, boundary supports, and buntings, (3) slow handling for improving infant's tolerance, (4) developing self-regulation, (5) using oral feeding, and (6) facilitating parent-infant interaction.[23]

The importance of sleep for premature infants is the reason that researchers are conducting more interventional studies to improve sleep quality. Liaw *et al*. analyzed the effects of sleep positions on sleep-wake modes of premature infants (GA 27.6–36.1 weeks) and concluded that nonnutritive sucking and positioning should be appropriately provided to facilitate infants' sleep.[13] Ferrari *et al*. conducted research in Italy entitled "Posture and movement in healthy preterm infants in the supine position in and outside the nest" and concluded that nesting promotes flexion position which positively affects neuromuscular development and stress reduction.[24] Moreover, the results of several studies suggest that infant sleep is disturbed in NICUs by environmental circumstances and medical procedures performed by nurses. Meanwhile, no corrective measures are taken.[6] In addition, since in developmental care of premature infants, fetal exposure is recommended as a facilitator of autoregulation, it is suggested that infant sleep be improved by such measures as facilitated fetal tucking. This makes the infants calmer and facilitates their sleeping process. If this technique is done every time after the caring intervention, it can increase the total sleeping time of infants. To achieve this aim, there have been numerous studies. However, most of these studies have merely analyzed sleep types neglecting the analysis of sleep quantity. Hence, the current randomized clinical trial study compares the impact of flexed (facilitated fetal tucking) and extended (free body) postures on the daily sleep quantity of premature infants.

The following question was addressed in this study:

Do preterm infants put in facilitated fetal tucking posture show more daily sleep quantity compared to infants put in free body posture?

MATERIALS AND METHODS

This study is a randomized clinical trial which was conducted at the neonatal ward of Al-Zahra Teaching Hospital of Tabriz University of Medical Sciences in 2015. Infants were included if they met these criteria: (1) premature infants with GA of 33–36 weeks on study day, (2) birth weight >1500, (3) no limitation for position change, (4) no substance abusing mother, (5) disease condition acceptable for observation (illness severity indicated by the Neonatal Therapeutic Intervention Scoring System [NTISS] score <21), (6) no aminophylline or caffeine contained drugs use in the infants.

The environmental conditions were similar in all infants, that is, all infants were out of the incubator; room temperature was within 23°C–25°C; ambient light was within the 97–112 lx; and the sound quantities were within 46–66 db.

The exclusion criteria for the infants were: (1) congenital anomalies, (2) intrauterine growth restriction (small for GA), (3) septicemia, (4) intraventricular hemorrhage, (5) hyperbilirubinemia; infants with an eye shield, (6) required mechanical ventilation, (7) infants with a serious medical condition that required the use of LP or treatments such as tranquilizers, muscle relaxants, and analgesic drugs.

The study population consists of all premature infants hospitalized in neonatal ward of Al-Zahra Teaching Hospital of Tabriz. All parents of the infants who met the study criteria received a sheet introducing the study. The parents were notified of the study procedures, their right to withdraw from the study at any time, and protection of their infants' privacy. When parents agreed to their infants' participation, they signed a written parental permission document.

The two postures and two positions (total: Four types) which were used as intervention processes in this study were as follows. In extended (free body) posture in the supine position; infant laid in a position faced up, and back to the bed. Movements were spontaneous and based on infant's muscular tone. In extended (free body) in lateral positions; infant laid on the right or left side of his/her body while the feet and hands were on the sides. Movements were spontaneous and based on infant's muscular tone. Infant's back and belly were protected by rolled soft cloth. In flexed (facilitated fetal tucking) posture in the supine positions, infant laid in a position faced up and back to the bed. The feet and hands were in flexion. U-form rolled soft cloth was put around the infant for protection. In flexed (facilitated fetal tucking) posture in the lateral positions, infant laid on the right or left side of the body. The feet and hands were in flexion, the back of the infant was protected by C-form rolled soft cloth.

In this study, the infants were selected through hospitalization order and received intervention formulated before being performed by computer-based randomization as ABCD, BACD (random permutations method). In addition, the sample size was estimated based on a pilot study and GPower software.

Preliminary data were based on a preliminary sample containing 10 infants. Using data from the primary variable (sleep quantity) and considering confidence interval of 95%, and test power of 0.8, each group comprised 19 cases. Considering total 30% loss, the sample size in each group was estimated to be 25 people. This number was raised to 32 infants in each group for more confidence. Finally, the study was completed and analyzed with 128 daily sleep diagrams related to 32 neonates.

Data collection

In accordance with the authorities of Al-Zahra Teaching Hospital and after completing parents' informed consent, the researchers studied the eligible infants in a working time between 8 a.m and 8 p.m. After selection, every infant was studied for 4 days and in a 12-h period every day (8 a.m–8 p.m). The individual characteristics of the infants were completed by the use of their file documents. When the infants were put in the cot without any special procedure on them (in rest), each infant in a sequential format received one of the interventions in the whole day. This means that, 1 day the infants were put in facilitated fetal tucking at the right or left lateral positions during their resting hours; 1 day in free body posture at the right or left lateral positions; 1 day in facilitated fetal tucking at the supine positions; and 1 day in free body posture at the supine position. It should also be pointed that during all the manipulations, caring and curing processes the infants' positions were chosen by the curer and caretaker. Furthermore, the infants were left without any structured intervention after 8 p.m and received the routine cares (wash out). The other intervention round started at 8 a.m next day.

Following all safety standards, four SCS 900 tvl closed circuit video cameras were installed in Al-Zahra Hospital's neonatal ward. The cameras were installed on the walls (40 cm-vertical) distant from the infants' faces, so the researchers could monitor infants' facial expressions, opening and closing of eyes, and the movements of infants' eyes in the recorded films during intervention period (12 h).

Keeping body positions and postures of the infants was done by 2 trained nurses. The nurses were directly

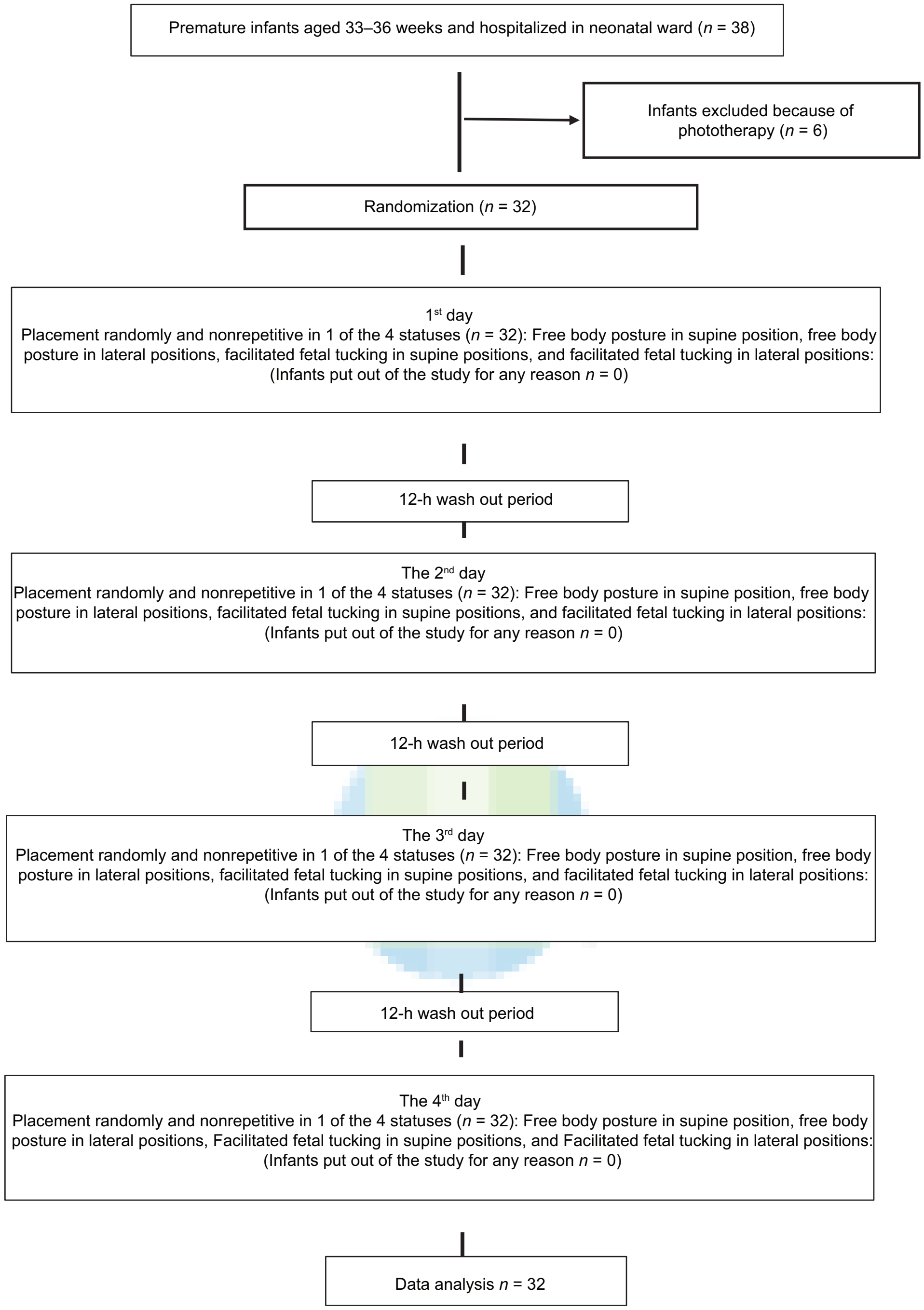

Figure 1: Flowchart of the study

controlling the infant's body states during infant's resting hours. The processes of data gathering for each infant (in four 12-h period) were completed in 4 days. Then, the effects of all four intervention types on daily sleep quantity of the infants were recorded for analysis.

All the information in researchers' checklist was made by sleep diagram,[25] which had the same code with that of the recorded film. Moreover, the validity of the checklist was assessed through content and face validity and also the feedback from ten faculty members of Tabriz University of Medical Sciences. Some needed modifications were made after receiving faculty members' comments on the study tool. To determine the reliability value among two observers, ten recorded films were used. The percentage to recognize sleep mode was 0.96 and for wakefulness mode was 0.97. Afterward, two people watched and analyzed the films.

Sleep and wakefulness states of infants were recorded every 5 min, then the total durations of sleep and wakefulness in the 12-h period were obtained. In each 12-h period (equal to 720 min), sleep and wakefulness durations (minutes) of the infants were recorded. To follow ethical codes and appreciate family-centered caring, parents - particularly mothers - were allowed to have their babies whenever they requested. Such durations, in which the babies were out of the camera zone, and it was impossible to directly observe infants' behavioral states were considered as missed data periods. Moreover, the durations of giving medical or nursing services and other cares such as kangaroo mother care and massaging were assumed as missed data.

To recognize sleep and wakefulness modes, the "state" part of Assessment of Preterm Infant Behavior scale was used.[26] Flowchart of the study is showed in Figure 1.

Statistical methods

In this study, after data collection and encoding, the analysis was started through the use of SPSS Statistics ver. 13.0 (SPSS Inc., Chicago, IL, USA) software and after checking normality, the mean (standard deviation) and median were used to summarize the accumulated data. The significance level was set at 0.05. In the current study, sleep and wakefulness modes were considered as the Response variables. Meanwhile, body postures and body positions were assumed as Independent variables. A two-way mixed model analysis with the main and interaction effect of body postures and body positions was used, considering risk evaluation and mitigation strategies estimation method, and AR1 covariance structure. Body statuses were taken as fixed effect while the ID numbers of participants were considered as random effect in the model.

RESULTS

The characteristics of the 32 infants are shown in Table 1. As it's observed, no significant group differences were found for any variables including gender, GA, postconceptual age, birth weight, weight at the beginning of exposure, length of hospital stay, and Apgar scores. There was no statistically significant difference between feeding types of the groups (fully breastfed, partially breastfed, or nasogastric tube) ($P > 0.05$).

Confounding variables are listed in Table 2. As it is observed, no significant differences were found for any variable between the groups. The variables include weight on the study day, number of procedures, number of feedings, milk intake at every turn, and the NTISS score.

The sleep variable-related descriptive statistics and tests were shown in Table 3. According to the results of mixed model analysis on sleep-dependent variable, there was not a significant interaction effect among posture and position ($F_{(1,89)}$ =0.11, $P = 0.746$).

Table 1: Demographic and clinical characteristics of infants (*n*=32)

Variable	In four groups•
Gender (female:male ratio)	15:17
GA, week	31.4±2.8
PCA at the beginning of exposure, week	34.34±1.12
Birth weight, g	1721.8±595.15
Weight at the beginning of exposure, g	2018.75±415.78
Length of hospital stay, day	9±8.67
Apgar score 1st min after birth*	8
Apgar score 5th min after birth*	9

•Because of the same infants, the measures in four groups are as the same. Data are presented as mean±SD or *Median or ratio. PCA = Postconceptual age; SD = Standard deviation; GA = Gestational age

About the main effect of posture for sleep variable; results showed there was a statistically difference ($F_{(1,124)}$ = 9.17, P = 0.003)., a general comparison between extended (free body) posture and flexed (facilitated fetal tucking) posture showed high amount of sleeping duration in flexed posture (mean difference = 41.9, CI 95% = (14.51-69.30)]. In addition, about the main effect of position for sleep variable; the results showed there was a significant statistically difference ($F_{(1, 90)}$ = 10.45, P = 0.002). Furthermore, the mean duration of sleep in the lateral position was more than the supine position (mean difference = 30.44, confidence interval [CI] 95%= [11.74–49.14]).

The wakefulness variable-related descriptive statistics and tests were shown in Table 4. The results of mixed model analysis on wakefulness dependent variable, there was no a significant interaction effect among posture and position ($F_{(1,89)}$ = 0.021, P = 0.886).

About the main effect of posture for wakefulness variable; result showed there was a significant statistically difference ($F_{(1,122)}$ = 7.11, P = 0.009). So that, the mean of wakefulness time in flexed (facilitated fetal tucking) posture was less than extended (free body) posture (mean difference = 23.69, CI 95% = [6.11–41.27]).

Meanwhile, about the main effect of position for wakefulness variable; the results showed there was no statistically significant difference ($F_{(1,80)}$ = 0.652, P = 0.422).

The time durations when babies were out of the cot for some procedures or routine family-centered care were considered as missed data for all cases. Missed data duration for the free body posture in supine position group was 143.14 min (19.88%); in the free body posture in lateral position group was 122.32 min (16.93%); in the

Table 2: Statistics for comparison of confounding variables among study groups

Variable	Free body posture in supine position	Free body posture in lateral position	Facilitated fetal tucking in supine position	Facilitated fetal tucking in lateral position	*P*
Weight on the study day, g	2062.81 (391.37)	2061.81 (402.45)	2056.87 (420.35)	2061.87 (413.96)	0.99
The number of procedures, *n*/12 h	3.90 (1.14)	3.71 (1.50)	3.34 (0.93)	4.03 (1.25)	0.07
The number of feeding, *n*/12 h	6.25 (1.81)	6.56 (1.56)	5.93 (1.72)	6.43 (1.31)	0.12
The intake milk at every turn, cc	23.90 (10.46)	24.43 (11.15)	24.50 (9.96)	24.68 (9.85)	0.95
NTISS♦	4 (2.34)	3.68 (2.37)	3.93 (2.38)	3.68 (2.48)	0.56

Reported as mean (SD), in minutes (decimal) or number of bouts. Mixed model analysis. ♦NTISS evaluate the illness severity. NTISS = Neonatal Therapeutic Intervention Scoring System, (scoring system is between 0 and 47); SD = Standard deviation

Table 3: Descriptive statistics and mixed model analysis for sleeping

Posture	Sleep[a] (min/12 h)			
	Position		Main effect of position	Interaction effect between posture and position
	Supine	Lateral		
Extended (free body)	467.9 (85.44)	494.87 (79.83)	$F_{(1,89)}$=10.45, *P*=0.002	$F_{(1,89)}$=0.11, *P*=0.746
Flexed (facilitated fetal)	506.34 (95.89)	540.25 (64.15)		
Main effect of posture	$F_{(1,124)}$=9.17, *P*=0.003			

Dependent variables: Sleep. [a]Reported as mean (SD), in minutes (decimal) of bouts. Mixed model analysis. SD = Standard deviation

Table 4: Descriptive statistics and mixed model analysis for wakefulness

Posture	Wakefulness[a] (min/12 h)			
	Position		Main effect of position	Interaction effect between posture and position
	Supine	Lateral		
Extended (free body)	108.96 (55.03)	102.81 (56)	$F_{(1,80)}$=0.652, *P*=0.422	$F_{(1,89)}$=0.021, *P*=0.886
Flexed (facilitated fetal)	84.24 (45)	80.15 (44)		
Main effect of posture	$F_{(1,122)}$=7.11, *P*=0.009			

Dependent variables: Wakefulness. [a]Reported as mean (SD), in minutes (decimal) of bouts. Mixed model analysis. SD = Standard deviation

facilitated fetal tucking in supine position group was 129.42 min (17.97%), and in the facilitated fetal tucking in lateral position group was 99.60 min (13.83%).

Although the percentage of missed data was over 10%, it was ignored to gain balance between the four groups. In addition, the percentage of missed data in each group is less than the total expected amount of loss (30%) in the whole sample size.

DISCUSSION

This study compared the effect of flexed and extended sleeping postures on daily sleep quantity of hospitalized premature infants. In addition, in this study, the effects of posture and positions were analyzed on infants'daily sleep quantity. The current study's mean and standard deviation quantities for sleep prove that sleep durations in the infants experiencing facilitated fetal tucking are higher. Furthermore, when put in a similar posture, the infants' sleep time in lateral position is higher than supine position.

Our findings are in accordance with the findings of the previous researches. As Liaw *et al*. discussed the effect of positions on the premature infants, lateral position has a good effect on infants' quiet sleep.[13] It should also be mentioned that in the current study, the mean duration of sleep in lateral position is more than supine position. This is congruent with the results of Liaw *et al*., 2012.[13]

In the other study conducted by Ferrari *et al*., it was shown that nesting the infant improves the flexion in the limbs. At the same time, it can improve the neuromuscular development and infants' sleep while reducing the stress.[24] Moreover, Hill *et al*. discussed the effect of facilitated fetal tucking in routine care of premature infants. Through the study, they indicated that facilitated fetal tucking reduces stress in infants. Therefore, they may be better able to maintain stability in their autonomic, motor, and state systems.[27]

In this study, we also showed that fetal posture facilitates infants' sleep and reduces infants' wakefulness. Furthermore, the results of this study showed that lateral position increases the amount of sleep time.

Inevitably, this study had some limitations which might influence its findings. First of all, this study was implemented for the infants ranging from 33 to 36 weeks and weighing more than 1500 g. Therefore, we cannot generalize its results to all the premature infants. Furthermore, the infants with medical and congenital disorders or those receiving advanced medication (with high NTISS score) were not included in the study. Hence, we cannot generalize the findings to such infants, too. Finally, in the current study, researchers did not cover some items including the effect of prone position in two facilitated fetal tucking and free body postures on the sleep duration of infants because the data collection was done by film recording and it was hard to record the infants' faces in the prone position. Hence, the prone position was not used during daily interventions. In addition, the effect of facilitated fetal tucking on quiet sleep, active sleep, and the transitional stage between sleep and wakefulness modes were not studied.

CONCLUSIONS

The results showed that flexed (facilitated fetal tucking) posture has more positive effect on the daily sleep quantity in comparison to free body posture. Meanwhile, fetal tucking posture decreases wakefulness time of the hospitalized premature infants.

Regarding the effect of positions, it should be pointed out that the lateral position increases the mean duration of sleep in premature infants in comparison to the supine position.

Based on the findings of the research, the positive effects of facilitated fetal tucking and lateral positions were more emphasized and can be considered as the fundamental caring procedures in the NICUs and neonatal wards to improve the sleep quantity which is one of the basic and important needs of premature infants. There should also be some policies for better implementation of this technique in the hospitals.

The current study assessed sleep quantity in 12 h with different postures and positions, but the researchers suggest for more studies to be conducted to evaluate the effect of prone position on premature infants' daily sleep quantity. In addition, the effects of facilitated fetal tucking on sleep stages (including quiet sleep, active sleep, and transitional stage), weighing process, digesting the milk, behavioral signs, and premature infants' physiologic criteria need to be studied more.

Acknowledgments

The researchers obtained approval from the Ethics Committee of Tabriz University of Medical Sciences (number: 9358) and submitted the study to IRCT website under the code of 201407088315N9.

We cordially thank research deputy and all the executives, doctors and the nurses of Al-Zahra Teaching Hospital and those beloved mothers who helped us with the participation of their infants. We also thank all those who kindly helped the researchers in the implementation phase of the study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

AUTHORS' CONTRIBUTION

- LV: LV conceptualized and designed the study, drafted the initial manuscript, and approved the final manuscript as submitted, she also designed the data collection materials and prepared the final manuscript
- GG: GG conceptualized and designed the study, drafted the initial manuscript, and approved the final manuscript as submitted. She also designed the data collection materials, trained co-researchers, and prepared the final manuscript
- MMG: MMG assisted in the study design, helped to interpret the results, and edited the final manuscript
- MAJ: MAJ provided randomization before data collection, provided statistical analysis of the outcomes, and edited the final manuscript.

REFERENCES

1. Rudolph C, Rudolph A, Lister G, First L, Gershon A. Rudolph's Pediatrics. 22th ed. New York: McGraw-Hill Education/Medical; 2011.
2. Beck S, Wojdyla D, Say L, Betran AP, Merialdi M, Requejo JH, *et al.* The worldwide incidence of preterm birth: A systematic review of maternal mortality and morbidity. Bull World Health Organ 2010;88:31-8.
3. Foreman SW, Thomas KA, Blackburn ST. Individual and gender differences matter in preterm infant state development. J Obstet Gynecol Neonatal Nurs 2008;37:657-65.
4. Arditi-Babchuk H, Feldman R, Eidelman AI. Rapid eye movement (REM) in premature neonates and developmental outcome at 6 months. Infant Behav Dev 2009;32:27-32.
5. O'Callaghan FV, Al Mamun A, O'Callaghan M, Clavarino A, Williams GM, Bor W, *et al.* The link between sleep problems in infancy and early childhood and attention problems at 5 and 14 years: Evidence from a birth cohort study. Early Hum Dev 2010;86:419-24.
6. Allen KA. Promoting and protecting infant sleep. Adv Neonatal Care 2012;12:288-91.
7. Als H. Reading the premature infant. In: Goldson E editors, Nurturing the premature infant: Developmental interventions in the neonatal intensive care nursery. NewYork: Oxford University press; 1999. p.18-85.
8. Anders TF, Keener M. Developmental course of nighttime sleep-wake patterns in full-term and premature infants during the first year of life. I. Sleep 1985;8:173-92.
9. Mirmiran M. The function of fetal/neonatal rapid eye movement sleep. Behav Brain Res 1995;69:13-22.
10. Graven S. Sleep and brain development. Clin Perinatol 2006;33:693-706, vii.

11. Thoman EB. Sleep-wake states as context for assessment, as components of assessment, and as assessment. In: Singer LT, Zeskind PS, editors. Biobehavioral Assessment of the Infant. NewYork: Guilford press; 2001. p. 125-48.
12. Vandenberg KA. Individualized developmental care for high risk newborns in the NICU: A practice guideline. Early Hum Dev 2007;83:433-42.
13. Liaw JJ, Yang L, Lo C, Yuh YS, Fan HC, Chang YC, *et al.* Caregiving and positioning effects on preterm infant states over 24 hours in a neonatal unit in Taiwan. Res Nurs Health 2012;35:132-45.
14. Als H. Toward a synactive theory of development: Promise for the assessment and support of infant individuality. Infant Ment Health J 1982;3:229-43.
15. Als H. A synactive model of neonatal behavioral organization: Framework for the assessment of neurobehavioral development in the premature infant and for support of infants and parents in the neonatal intensive care environment. Phys Occup Ther Pediatr 1986;6:3-53.
16. Jarus T, Bart O, Rabinovich G, Sadeh A, Bloch L, Dolfin T, *et al.* Effects of prone and supine positions on sleep state and stress responses in preterm infants. Infant Behav Dev 2011;34:257-63.
17. Zarem C, Crapnell T, Tiltges L, Madlinger L, Reynolds L, Lukas K, *et al.* Neonatal nurses' and therapists' perceptions of positioning for preterm infants in the neonatal Intensive Care Unit. Neonatal Netw 2013;32:110-6.
18. Axelin A, Salanterä S, Lehtonen L. 'Facilitated tucking by parents' in pain management of preterm infants-a randomized crossover trial. Early Hum Dev 2006;82:241-7.
19. Ward-Larson C, Horn RA, Gosnell F. The efficacy of facilitated tucking for relieving procedural pain of endotracheal suctioning in very low birthweight infants. MCN Am J Matern Child Nurs 2004;29:151-6.
20. Corff KE, Seideman R, Venkataraman PS, Lutes L, Yates B. Facilitated tucking: A nonpharmacologic comfort measure for pain in preterm neonates. J Obstet Gynecol Neonatal Nurs 1995;24:143-7.
21. Neu M, Browne JV. Infant physiologic and behavioral organization during swaddled versus unswaddled weighing. J Perinatol 1997;17:193-8.
22. Ariagno RL, Thoman EB, Boeddiker MA, Kugener B, Constantinou JC, Mirmiran M, *et al.* Developmental care does not alter sleep and development of premature infants. Pediatrics 1997;100:E9.
23. Fleisher BE, VandenBerg K, Constantinou J, Heller C, Benitz WE, Johnson A, *et al.* Individualized developmental care for very-low-birth-weight premature infants. Clin Pediatr (Phila) 1995;34:523-9.
24. Ferrari F, Bertoncelli N, Gallo C, Roversi MF, Guerra MP, Ranzi A, *et al.* Posture and movement in healthy preterm infants in supine position in and outside the nest. Arch Dis Child Fetal Neonatal Ed 2007;92:F386-90.
25. Shimada M, Takahashi K, Segawa M, Higurashi M, Samejim M, Horiuchi K. Emerging and entraining patterns of the sleep-wake rhythm in preterm and term infants. Brain Dev 1999;21:468-73.
26. Goldson E. Nurturing the Premature Infant: Developmental Intervention in the Neonatal Intensive Care Nursery. 1st ed. NewYork: Oxford University Press: Oxford University Press; 1999.
27. Hill S, Engle S, Jorgensen J, Kralik A, Whitman K. Effects of facilitated tucking during routine care of infants born preterm. Pediatr Phys Ther 2005;17:158-63.