Effect of Mothers' Heartbeats Combined with Swaddling Technique on Orogastric Tube Insertion Pain among Preterm Neonates

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Abstract

Preterm neonates experience pain with several procedures within the Neonatal Intensive Care Units (NICUs). Significant evidences prove that controlling the neonates' pain is helpful in improving physiological, hormonal, and behavioral outcomes. Therefore, it is reasonable to manage preterm neonates' pain by integrating innovative non-pharmacological pain measures that will help those neonates to handle the stressful situations. **Aim:** The aim of this study was to determine the effect of mothers' heartbeats combined with swaddling technique on Orogastric Tube (OGT) insertion pain among preterm neonates. **Research Design**: A quasi- experimental research design was used. **Setting**: The study was done at the NICU of National Medical Institute, Damanhour City, Al-Behira Governorate, Egypt. **Subjects**: A convenience sampling of 60 preterm neonates comprised the study subjects. Those neonates were divided equally into a study group (listened to mothers' heartbeats combined with swaddling technique along with routine NICU care) and a control group (received NICU routine care only). **Tools**: Two tools were utilized to gather required data, i.e. Characteristics and Medical Data of Preterm Neonates, and Premature Infant Pain Profile (PIPP). **Results**: During OGT insertion, the pain score recorded for 80.0% of preterm neonates in the study group was lower than or equivalent to 6 which entails that insertion of OGT did not cause pain. Simultaneously, 50.0% of those in the control one had moderate to slight pain as they achieved 7-12 pain score. Moreover, the mean PIPP score was 5±1.92 among those neonates in the study group compared to 9±3.43 among preterm neonates in the control group and there was a statistical significant difference where P=0.001. Immediately after OGT insertion, 93.3% of preterm neonates in the study group perceived no pain compared to 66.7% of those in the control group. Furthermore, the mean PIPP score reduced to 4.5±2.61 in the study group compared to 6±7.55 in the control group with a statistical significant difference (P= 0.000). **Conclusion**: mothers' heartbeats combined with swaddling technique were beneficial in decreasing preterm neonates' feeling with pain during and immediately following OGT insertion. **Recommendation:** mothers' heartbeats combined with swaddling technique should be included in the NICUs policies and the written guidelines regarding painful intervention.

Keywords: Mothers' heartbeats, swaddling technique, orogastric tube insertion pain, preterm neonates.

Introduction

It was estimated that 15 million preterm neonates were born every year. Worldwide, above one million of those neonates died as a consequence of prematurity (World Health Organization, 2018). Preterm neonates transfer abruptly from the protective intrauterine environment to a relatively aggressive surroundings of the Neonatal Intensive Care Units (NICUs), where they exposed to a diversity of diagnostic and therapeutic life-saving invasive procedures (Mohammed, 2018). During hospitalization, the feeling of pain inherent in the required procedures is frequent encountering around fourteen painful procedures every day (Williams & Lascelles, 2020).

Generally preterm neonates have poor oral feeding skills as the ability to latch, suck efficiently as well as to quite coordinate breathing with sucking and swallowing (Arafa et al, 2021; Louyeh et al., 2020; Radwan & Mohammed, 2019). Furthermore, they are exposed to many health complications, as respiratory distress syndrome, hyperbilirubinemia, and hypoglycemia. Those health complications may also inhibit their oral

feeding abilities. Thus, it is essential to shift to alternative suitable feeding method, such as, Nasogastric/ Orogastric (NG/OG) tube feeding for providing those neonates with sufficient nutrition for growth (Hockenberry & Wilson, 2017; Lyman et al., 2016).

Specialists in pain among newborns recognized that, insertion of feeding tube was associated with pain feeling they ranked its severity as moderate pain. Additionally, those newborns exhibited extra pain related to reinsertion if the tube blocked or extubated (Badran et al., 2021). Unfortunately, this pain insult happens in the critical phase of brain development. Therefore, the preterm neonates may suffer from harmful developmental problems later on in childhood. Hence, consideration should be directed to the vital indicators of pain specially; physiological and behavioral signs. The physiological indicators include alterations in oxygen saturation level and heart rate. Whereas the behavioral cues involve changes in facial expressions and crying (Hockenberry & Wilson, 2017).

Appropriate pain management begins with pain assessment with a competent objective tool. The Premature Infant Pain Profile (PIPP) scale is a standard valid and reliable tool used for pain assessment. It can be used for both premature and mature neonates less than two months of age. The PIPP is a 7-indicator pain measure that comprises behavioral, physiological, and contextual indicators. Three behavioral (facial actions: brow bulges, nasolabial furrow and eye squeeze), two physiological (oxygen saturation and heart rate), and two contextual (gestational age and behavioral state) (Stevens et al., 1996).

Pain sensation can be controlled through both pharmacological and non-pharmacological interventions. It is well known that using of analgesics is not recommended for neonates because of the probable negative side effects. Meanwhile, non-pharmacological interventions are available, cost-effective, and have confirmed variable degrees of effectiveness. These interventions can be categorized into Developmental Supportive Care (DSC) as swaddling and facilitated tucking, multisensory stimulation as olfactory and auditory recognition, in addition to mother-driven interventions as Kangaroo Mother Care (KMC) and listening to mothers' heartbeats (Campbell-Yeo et al., 2011; Inal et al., 2021).

The goal of developmental supportive care is to influence the neonatal environment to reduce external stressors (Sathish et al., 2019). Swaddling technique is inside the scope of DSC, and it is considered one of the most significant techniques that stimulate in-utero feeling (Fallah et al., 2017).

Swaddling is an intervention that intends to limit the neonates' boundaries, help self-regulation, and diminish behavioral stress and physiological changes caused by severe pain (McNair et al., 2019). It is wrapping naked neonate with a clean diaper in a light blanket and avoids face covering. Currently, it is a common mean of calming irritable neonates, and assisting them to sleep. It also reduces spending their energy through reduction of neonates' movements. This significantly diminishes the stress triggered by motor disorganization related to painful stimuli (Inal et al., 2021).

Recently, there has been a growing awareness about applying a role for the mothers of preterm neonates as promoters for growth and mediators for pain relief in the NICUs. The concept of mother-driven interventions involves many strategies as: KMC, listening to mothers' voices and mothers' heartbeats which are designed to decrease stress among preterm neonates in the NICUs (Campbell-Yeo et al., 2011; Inal et al., 2021).

The whole sensory organs in the fetus develop through the prenatal period. Hearing sense usually starts in the 18th week of gestation and almost matures in the 28th week. Fetal reaction to sounds arises in the 26th–28th week. After delivery, the neonate may become familiar with the sounds which he heard several times as: mother's heartbeats, voice, sounds of respiration, bowel movements as well as cardiovascular system (Webb et al., 2015).

The American Academy of Pediatrics (AAP) suggested that the sound level in the NICUs should not go above 45 dB. It is a massive problem for preterm neonates to be

subjected to extreme sound stimuli in NICUs. At the same time, they are deprived from the mother's voice, which is a vital source for the development of sound sensation of the neonates (Coston & Aune, 2019).

Excessive NICU sounds in addition to frequent painful procedures expose these neonates to stressful situations. Consequently, there is an increase in the production of stress hormone with subsequent neonatal behavioral reactions as fatigue and hyperalertness as well as physiological changes including a rise in heart rate and a reduction in oxygen saturation level. Thus, it is reasonable to soothe these neonates using the familiar auditory stimulus as mothers' heartbeats along with a swaddling technique that may provoke security feeling within the mothers' wombs. These interventions will enhance neonates' physiological stability, suppress the pain response and provide a cognitive effect for pain control (Alemdar & Tüfekci, 2017; Dilek & Güdücü, 2018). Swaddling technique helps to divert neonates' attention away of the painful procedure. The mechanism of action by which mothers' heartbeats blunt pain responses is built on the gate control theory and the production of endogenous opioids that may prompt calming and analgesic effects (McNair et al., 2019).

Significance of the study:

Control of preterm neonates' pain during painful procedures like insertion of Orogastric Tubes (OGT) is a great challenge for neonatal nurses. Consequently, they have a crucial role in pain assessment, prevention and management to prevent its potential adverse effects. It is recommended for neonatal nurses to apply mothers' heartbeats and swaddling technique in a safe and effective manner to relieve neonatal pain (Hockenberry & Wilson, 2017). Studies looking into the incorporation of such interventions in the NICUs during painful procedures are limited. Optimistically, the current study would implement mothers' heartbeats combined with swaddling technique to reduce the preterm neonates' pain response in the NICU.

This study aimed to:

Determine the effect of mothers' heartbeats combined with swaddling technique on OGT insertion pain among preterm neonates.

Research Hypothesis:

Preterm neonates who listen to mothers' heartbeats combined with swaddling technique had lower pain score during OGT insertion than those who do not.

Operational Definition:

Swaddling Technique: In the current study, the term tends to placing the naked preterm neonate with only clean diaper in a sheet and securely wrapping him where; his legs are flexed and his head, neck, shoulders and hips are kept in a neutral position. His arms are positioned near to his torso with clinching both hands to constrain neonate's arms from moving freely.

Materials and Method

Materials

Research Design

A quasi experimental research design was used to accomplish this study.

Setting

The study was carried out at the Neonatal Intensive Care Unit of Damanhour National Medical Institute affiliated to Ministry of Health in Damanhour City, Al-Behira Governorate, in Egypt. The NICU consists of three rooms. Each room contains 10-15 incubators. It provides services for critically ill neonates in Al-Behira Governorate.

Subjects

- Sample size was calculated according to Epi-Info program using the following parameters:
  - Population size =110 preterm neonates (representing the average number of

neonates admitted to the previously mentioned setting in the last three months before data collection).

- Expected frequency = 50%
- Margin of error =5%
- Confidence coefficient =95%
- Minimum sample size = 57 preterm neonates

- A convenience sampling of 60 preterm neonates who matched the following criteria constituted the study subjects:
  - Gestational age of 28 to <37 weeks
  - Postnatal age: 4 days after labor to permit for resolution of anesthesia received from their mothers throughout delivery till before 2 months of age.
  - Being fed through OGT.
  - Did not have neurological or congenital malformation.
  - Did not have any analgesics or sedatives.
  - Critically ill preterm neonates and those on mechanical ventilator were excluded.
- Eligible preterm neonates who met the inclusion criteria were randomly allocated into two equal groups as illustrated in **Figure 1** one neonate was allocated to the study group and the following one was allocated to the control group alternatively.
- Each group contained 30 preterm neonates as follows:
  - **The study group (MH and ST)**: where preterm neonates listened to mothers' heartbeats combined with swaddling technique besides standard care of the NICU.
  - **The control group**: where preterm neonates received just the NICU standard care.

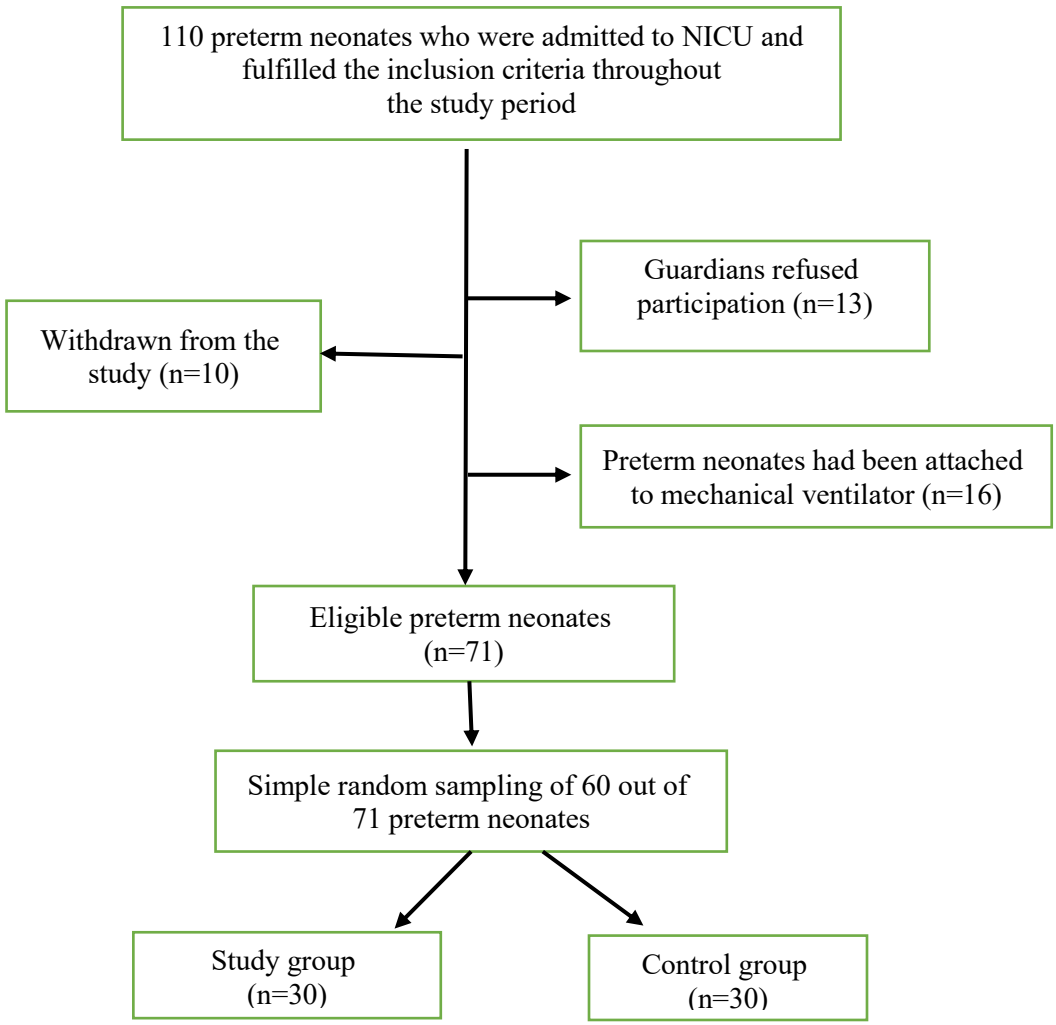

Figure (1): Flow chart of participants' recruitment process.

Tools

Two tools were used to collect the required data.

Tool one: Characteristics and Medical Data of Preterm Neonates

This tool was developed by the researchers to assess preterm neonates' characteristics and their medical history. It included two parts:

Part I: Characteristics of Preterm Neonates, as: postnatal age, gender and current weight.

Part II: Medical Data of Preterm Neonates, such as: gestational age, diagnosis and type of delivery, date of admission.

Tool Two: **Premature Infant Pain Profile (PIPP)**:

It is a bio-behavioral observational assessment for pain. It was developed by Stevens et al (1996) to assess procedural pain in both preterm and term neonates. This scale was adopted by the researchers to assess OGT insertion pain among preterm neonates. The **PIPP** is a valid and reliable pain assessment scale. Its validity yielded 87.0% and its reliability estimated 0.85. The PIPP includes seven indicators as follows:

1. Gestational age
2. Behavioral state.
3. Increase in heart rate.
4. Decrease in oxygen saturation.
5. Brow bulges.
6. Eye squeeze.
7. Nasolabial furrow.

Each of these items is measured on a four-points Likert scale ranging from (0–3).

The total score of PIPP is the SUM of points for all seven indicators. It is ranging from 0-21. The higher score representing more pain. **A score** from **0-6** indicates no pain, **a score** from **7-12** denotes slight to moderate pain, while, a **score >12** means severe pain.

Method

1. Permission was obtained from the Research Ethics Committee of the Faculty of Nursing, Damanhour University before carrying out the study.
2. A formal letter was sent from the Faculty of Nursing, Damanhour University to the hospital managerial persons in NICU at Damanhour National Medical Institute for approval to conduct the study with a clarification of the study aim.
3. Tool one was formed by the researchers. **PIPP** (Tool two) was developed by Stevens and his colleagues (1996) and was adopted by the researchers.
4. Tool one and two revised by a panel of five specialists in the neonatal and pediatric nursing fields to check their content validity.
5. A pilot study was conducted on 6 preterm neonates (10% of total sample size) to check the clarity and the applicability of the tools and no modification was done. Those neonates were not involved in the study.
6. The researchers collected the required data during morning and evening shifts.
7. Subjects were distributed into two groups. The study group was listening to mothers' heartbeats combined with swaddling technique along with the routine NICU care and the control group received only routine NICU care.
8. Characteristics and medical data of all preterm neonates in the two groups were collected from neonatal files using tool one.
9. Before OGT insertion, the neonate was attached to pulse oximeter, then pain was assessed for every preterm neonate in the two groups as an initial data using tool two **(PIPP)** as illustrated by the following steps:

A: The researchers recorded the preterm neonates' gestational age that were calculated by the neonatologist from the neonates' medical files.

B: The researchers checked and scored the neonatal facial expression (brow bulges, nasolabial furrow and eye squeeze) and his behavioral state by close observation for 15 seconds (Stevens et al., 1996).

C: Oxygen saturation and heart rate were recorded from pulse oximeter.

D: The researchers observed the changes and scored all indicators according to the **PIPP** scale then calculated the total score of pain for each preterm neonate.

10- For the study group swaddling technique combined with mothers' heartbeats were applied as the following steps:

A- Every preterm neonate in the study group listened to the mother's heartbeats combined with swaddling technique for 10 minutes before insertion of OGT and continued during the procedure and persisted 2 minutes after insertion.

B- Each preterm neonate listened to the recorded mother's heartbeats inside the incubator; mother’s heartbeats for every neonate were recorded by digitalized stethoscope. Recorded mother's heartbeats were played using wireless headphone, which has been validated for feasibility and safety. The decibel level was adjusted to 45dB (Van der Heijden et al., 2016) after consultation of a specialist.

C- Regarding the swaddling technique, the naked preterm neonate except for hygienic napkin was surrounded by a

thin bed sheet by a researcher as illustrated by the following steps:

- The researcher folded the sheet in triangular shape, and then located the neonate above it in supine position.
- The preterm neonate was laid in fetal position with his legs flexed and his head, neck, shoulders and hips were in a normal position, both arms are positioned near to his torso to prevent neonate's arms from moving freely.
- The horizontal ends of the sheet were bent in reverse directions to surround the preterm neonate's torso.
- Then the residual part of the wrap was folded under the preterm neonate's back and fixed by his body weight. One foot is kept out of the cover to attach with the probe of a pulse oximeter.
- In this intervention, the preterm neonate was capable to move the pelvic joints smoothly (Inal et al., 2021).

11- The OGT was inserted by the responsible nurse for all preterm neonates in both the study and control groups.

12- **During OGT insertion,** the researchers observed the preterm neonate for 30 seconds i.e, the researchers observed the changes in the preterm neonate's behavioral state, facial expression, oxygen saturation as well as heart rate according to the **PIPP** scale to reassess the neonate's pain (Stevens et al., 1996). Then, these changes were recorded and scored immediately after the observation period by the researchers. Then, the researchers calculated the total score of pain for each preterm neonate.

13-**Immediately after OGT insertion**, the researchers also reassessed the pain for all preterm neonates in the two groups with the **PIPP** scale as explained previously.

14- Duration for pain assessment for every preterm neonate was about 10-15 minutes.

15-For the Control group: they received just standard care of the NICU.

16-A comparison between the study and the control groups was done to identify the effect of listening to mothers' heartbeats combined with a swaddling technique for diminishing preterm neonates' pain.

17- The data were gathered throughout seven months which began from the start of June 2021 till the end of December 2021.

18-Ethical considerations were maintained all through the study as follows**:**

- Informed written consents were achieved from the parents of premature newborns after explanation of the study objective.
- Parents are free to refuse their preterm neonates' participation and to leave the study at any moment.
- Anonymity of participants was kept, and confidentiality of the collected data was guaranteed.

Data Analysis

Data analysis was done using SPSS version 23 (Statistical Package for Social Sciences). To summarise the characteristics and medical data of the preterm neonates, descriptive statistics such as number, percentage, mean, and standard deviation were used. The standard deviation and mean were also used to describe the preterm neonates' oxygen saturation, heart rates and total pain percent score. Kolmogorov-Smirnov test was used to check the normality of study variables, and it showed that they were normally distributed. In analytical statistics, Student t-test was used to compare the differences and test the significance between the preterm neonates' mean heart rate, mean oxygen saturation and mean total pain percent score. Moreover, the Chi-square test was employed to assess the significance of the differences between the preterm neonates' characteristics and their medical data. In addition, the Fisher's Exact test was utilized to test the significance and compare the differences between the preterm neonates' behavioral state, oxygen saturation, increase in heart rate, facial changes and total pain percent score. At $P \leq 0.05$ all the statistical analyses were considered significant.

Results

Table 1: highlights the characteristics and medical data of the preterm neonates in both groups. Concerning their gender it was obvious

from the table that, male neonates constituted 66.7% of the preterm neonates in the MHandST group and 76.7% of those neonates in the control group. The current weight for the most of the preterm neonates in both the MHandST and control groups ranged from 2000 to less than 3000 grams (83.3% and 80.0% respectively). Their mean weights were 1.877±534.88 and 1.874±526.32 grams respectively.

Regarding medical data, more than three quarters of neonates (76.7%) in both groups were late preterm. Their mean gestational ages were 34.8±3.77 and 34.6±4.39 weeks for the MHandST and control groups respectively. hyperbilirubinemia was the most common diagnosis registered among preterm neonates in the MHandST and the control groups (46.7% and 60% respectively). The type of delivery was caesarean section for more than half of preterm neonates in the MHandST group (53.3%) and for 66.7% of those in the control group. There were no statistical significant differences among the preterm neonates in both groups in relation to their characteristics and medical data which denoted that both groups were matched.

The effect of mothers' heartbeats combined with swaddling technique on preterm neonates' behavioral state before, during and immediately after OGT insertion was revealed in **Table 2**. Before OGT insertion, it was clarified that nearly two thirds of preterm neonates in the MHandST group and the control group were active sleepers. Their eyes were closed and had facial movements (63.3% and 60.0 %, respectively) with no statistically significant difference. During OGT insertion, the same behavioral state was noticed among 50.0% of preterm neonates in the control group compared to almost half of those in the MHandST group (46.7%) who were quiet sleepers, their eyes were closed and had no facial movements and the difference was statistically significant (P= 0.045).

Immediately after OGT insertion, 56.7% of preterm neonates in the MHandST group and 50.0% of neonates in the control group exhibited similar behavioral state as they were quiet sleepers, their eyes were closed and had no facial movements. There was no a statistical significant difference between both groups.

Table 3 portrays the effect of mothers' heartbeats combined with swaddling technique on preterm neonates' heart rates before, during and immediately after OGT insertion. Before OGT insertion, it was obvious that all preterm neonates in the MHandST and the control groups exhibited a minor increase in their heart rates from 0-4 beats per minute (100% for each). During OGT insertion, it was noticed that the majority of preterm neonates in the MHandST group (86.7%) had minor increase in their heart rates from 0-4 beats per minute. Conversely, approximately half of those in the control group (46.7%) demonstrated an increase in their heart rates from 5 –14 beats per minute. The difference was statistically significant between the MHandST and control groups, where P=0.000. The mean heart rate among preterm neonates during OGT insertion was 135 ±6.12 for the MHandST group compared to 149±5.14 for the control group and the difference was statistically significant (P= 0.001).

Immediately after OGT insertion, it was apparent that the highest percentage of preterm neonates in the MHandST group (96.7%) and 83.3% of those in the control group experienced a minor increase in their heart rates. The difference was not statistically significant between both groups.

Table 4: clarifies the effect of mothers' heartbeats combined with swaddling technique on preterm neonates' oxygen saturation before, during and immediately after OGT insertion. Before OGT insertion, it was revealed that desaturation was not noticed among any preterm neonate of the two groups as there was minimal reduction in the oxygen saturation from zero to 2.4% (100% for each). During OGT insertion, it was found that oxygen desaturation was not detected among 90.0% of the preterm neonates in MHandST group in comparison with 50.0% among those in the control group. In addition, almost one third of preterm neonates in the control group (30.0%) experienced slight desaturation i.e. decline in their oxygen saturation "from 2.5 to 4.9%" with statistical significant difference between the MHandST and the control groups (P=0.004). The mean oxygen saturation among preterm neonates during OGT insertion was 97±5.11 and 93±7.76 for the MHandST group and

control group respectively with statistically significant difference, where P= 0.001.

Immediately after OGT insertion, it was noticed that all preterm neonates in the MHandST group and the highest percentage of preterm neonates in the control group (90.0%) did not exhibit oxygen desaturation. The difference was not statistically significant among the preterm neonates in both groups.

The effect of mothers' heartbeats combined with swaddling technique on preterm neonates' facial changes before, during and immediately after OGT insertion were showed in **Table 5**. Before OGT insertion it can be seen that all preterm neonates in the MHandST and control groups experienced no brow bulges, eye squeeze or nasolabial furrow (100% for each). However, during OGT insertion it was reflected that 80.0% of preterm neonates in the MHandST group demonstrated no brow bulges, eye squeeze or nasolabial furrow. Conversely, more than half of those in the control group (56.7%) showed minimum brow bulge, eye squeeze and nasolabial furrow. There was a statistical significant difference between the study and control groups (P=0.001).

Immediately after OGT insertion, it was noticed that the highest percent of preterm neonates in the MHandST group (96.7%) and 86.7% of those in the control group had no brow bulges, eye squeeze or nasolabial furrow. The difference was not statistically significant between both groups.

Table 6: presents the effect of mothers' heartbeats combined with swaddling technique on preterm neonates' total pain percent score before, during and immediately after OGT insertion. It was revealed that all preterm neonates in the MHandST and control groups had no pain before OGT insertion (100% for each). During OGT insertion, it was found that the pain score recorded for 80.0% of preterm neonates in the MHandST group was less than or equal 6 which denotes that OGT insertion did not cause any pain. On the other hand, it was illustrated that 50.0% of preterm neonates in the control group had slight to moderate pain during OGT insertion as they obtained 7-12 pain score. There was a statistical significant difference between both groups (P=0.001). Immediately after OGT insertion, 93.3% of preterm neonates in the MHandST group perceived no pain compared to 66.7% of those in the control group and the difference was statistically significant (P= 0.021).

It was also clear from **Table 6** and **Figure 2** that before OGT insertion, the mean total pain percent score recorded using PIPP was 4 ± 4.80 and 4 ± 3.19 for the study and the control groups respectively. However, during OGT insertion the mean PIPP score was 5±1.92 among preterm neonates in the MHandST group compared to 9±3.43 among those in the control group and the difference was statistically significant between both groups where P=0.000. Immediately after OGT insertion, the mean PIPP score reduced to 4.5±2.61 in the MHandST group compared to 6±7.55 in the control group with a statistical significant difference between both groups (P= 0.001).

Table 1: Characteristics and Medical Data of the Preterm Neonates in the MHandST and Control Groups

Characteristics and Medical Data	MHandST group Group (n=30)		Control group (n=30)		Test of Significance
	No.	%	No.	%	
Characteristics					
Gender		66.7	23	76.7	X = 0.739
• Male	20	33.3	7	23.3	P= 0.390
• Female	10				
Current Weight / grams	5	16.7	6	20.0	
• 1000 –	25	83.3	24	80.0	X^2 =0.111
• 2000 -<3000					P =0.739
Mean ± SD	1.877 ± 534.88		1.874 ± 526.32		
Medical Data					
Gestational Age					
• Moderately preterm (32 - < 34 weeks)	7	23.3	7	23.3	
• Late preterm (34 -< 37 weeks)	23	76.7	23	76.7	----------
Mean ± SD	34.8 ± 3.77		34.6 ± 4.39		

Diagnosis					
• Hyperbilirubinemia.	14	46.7	18	60.0	X = 1.083
• Congenital Pneumonia.	9	30.0	5	16.7	P= 0.651
• Respiratory Distress.	7	23.3	7	23.3	
Type of Delivery					
• Normal Vaginal Delivery.	14	46.7	10	33.3	X = 1.111
• Cesarean Section.	16	53.3	20	66.7	P= 0.292

X^2: Chi Square P: P value of Chi Square * Significant at P ≤ 0.05.

Table 2: Effect of Mothers' Heartbeats Combined with Swaddling Technique on Preterm Neonates' Behavioral State before, during and Immediately after Orogastric Tube Insertion

Behavioral State	Before Orogastric Tube Insertion				During Orogastric Tube Insertion				Immediately After Orogastric Tube Insertion			
	MHandST group (n=30)		Control Group (n=30)		MHandST group (n=30)		Control Group (n=30)		MHandST group (n=30)		Control Group (n=30)	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
• Active/awake, eyes open, facial movements.	5	16.7	5	16.7	1	3.3	6	20.0	1	3.3	2	6.7
• Quiet/awake, eyes open, no facial movements.	1	3.3	1	3.3	5	16.7	2	6.7	5	16.7	6	20.0
• Active /sleep, eyes closed, facial movements.	19	63.3	18	60.0	10	33.3	15	50.0	7	23.3	7	23.3
• Quiet /sleep, eyes closed, no facial movements.	5	16.7	6	20.0	14	46.7	7	23.3	17	56.7	15	50.0
Test of Significance (FET)	FET = 0.452, P= 1.000				**FET = 7.900, P= 0.045***				FET = 0.704, P= 0.952			

FET: Fisher's Exact Test P: P value of Fisher's Exact test * Significant at P ≤ 0.05.

Table 3: Effect of Mothers' Heartbeats Combined with Swaddling Technique on Preterm Neonates' Heart Rate Before, During and Immediately after Orogastric Tube Insertion

Increase in Heart Rate	Before Orogastric Tube Insertion				During Orogastric Tube Insertion				Immediately After Orogastric Tube Insertion			
	MHandST group (n=30)		Control Group (n=30)		MHandST group (n=30)		Control Group (n=30)		MHandST group (n=30)		Control Group (n=30)	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
• From 0-4 beats per minute.	30	100.0	30	100.0	26	86.7	10	33.3	29	96.7	25	83.3
• From 5-14 beats per minute.	0	0.0	0	0.0	3	10.0	14	46.7	1	3.3	2	6.7
• From 15-24 beats per minute.	0	0.0	0	0.0	1	3.3	4	13.3	0	0.0	3	10.0
• From 25 beats per minute and more.	0	0.0	0	0.0	0	0.0	2	6.7	0	0.0	0	0.0
Test of Significance (FET)	----------				**FET = 17.673, P= 0.000***				FET = 3.312, P= 0.227			
Mean ± S.D	133 ± 5.77		132 ± 4.15		135 ± 6.12		149 ± 5.14		133 ± 3.70		134 ± 4.19	
Test of Significance (t-test)	t = 1.657, P= 0.103				**t = 74.619, P= 0.001***				t = 1.702, P= 0.094			

P: P value of Fisher's Exact test /Student t- Test t= Student t- Test

Table 4: Effect of Mothers' Heartbeats Combined with Swaddling Technique on Preterm Neonates' Oxygen Saturation Before, During and Immediately after Orogastric Tube Insertion

	Before Orogastric Tube Insertion	During Orogastric Tube Insertion	Immediately After Orogastric Tube

Oxygen Saturation									Insertion			
	MHandST group (n=30)		Control Group (n=30)		MHandST group (n=30)		Control Group (n=30)		MHandST group (n=30)		Control Group (n=30)	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
• No desaturation "from 0 to 2.4% decrease.	30	100.0	30	100.0	27	90.0	15	50.0	30	100.0	27	90.0
• Slight desaturation "from 2.5 to 4.9% decrease	0	0.0	0	0.0	2	6.7	9	30.0	0	0.0	1	3.3
• Moderate desaturation "from 5 to 7.4% decrease	0	0.0	0	0.0	1	3.3	4	13.3	0	0.0	2	6.7
• Severe desaturation "from 7.5% decrease and more.	0	0.0	0	0.0	0	0.0	2	6.7	0	0.0	0	0.0
Test of Significance (FET)	----------				**FET = 11.001, P= 0.004***				FET = 2.718, P= 0.237			
Mean ± S.D	98 ± 2.38		98 ± 3.47		97 ± 5.11		93 ± 7.76		97 ± 3.88		97 ± 4.59	
Test of Significance (t-test)	----------				**t = - 18.655, P= 0.001***				----------			

Table 5: Effect of Mothers' Heartbeats Combined with Swaddling Technique on Preterm Neonates' Facial Changes before, during and Immediately after Orogastric Tube Insertion

Facial Changes	Before Orogastric Tube Insertion				During Orogastric Tube Insertion				Immediately After Orogastric Tube Insertion			
	MHandST group (n=30)		Control Group (n=30)		MHandST group (n=30)		Control Group (n=30)		MHandST group (n=30)		Control Group (n=30)	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
• No brow bulge, eye squeeze, and nasolabial furrow.	30	100.0	30	100.0	24	80.0	7	23.3	29	96.7	26	86.7
• Minimum brow bulge, eye squeeze, and nasolabial furrow.	0	0.0	0	0.0	3	10.0	17	56.7	1	3.3	1	3.3
• Moderate brow bulge, eye squeeze, and nasolabial furrow.	0	0.0	0	0.0	3	10.0	5	16.7	0	0.0	2	6.7
• Maximum brow bulge, eye squeeze, and nasolabial furrow.	0	0.0	0	0.0	0	0.0	1	3.3	0	0.0	1	3.3
Test of Significance (FET)	----------				**FET = 21.161, P= 0.001***				FET = 2.966, P= 0.483			

Table 6: Effect of Mothers' Heartbeats Combined with Swaddling Technique on Preterm Neonates' Total Pain Percent Score before, during and Immediately after Orogastric Tube Insertion

Total Pain Percent Score	Before Orogastric Tube Insertion				During Orogastric Tube Insertion				Immediately After Orogastric Tube Insertion			
	MHandST group (n=30)		Control Group (n=30)		MHandST group (n=30)		Control Group (n=30)		MHandST group (n=30)		Control Group (n=30)	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
No pain **(0 - 6).**	30	100.0	30	100.0	24	80.0	11	36.7	28	93.3	20	66.7
Slight to moderate pain **(7-12).**	0	0.0	0	0.0	6	20.0	15	50.0	2	6.7	9	30.0
Severe pain **(>12).**	0	0.0	0	0.0	0	0.0	4	13.3	0	0.0	1	3.3
Test of Significance (FET)	----------				**FET = 12.327, P= 0.001***				**FET = 6.634, P= 0.021***			
Mean ± S.D	4 ± 4.80		4 ± 3.19		5 ± 1.92		9 ± 3.43		4.5 ± 2.61		6 ± 7.55	
Test of Significance (t test)	----------				**t = 18.655, P= 0.001***				**t = 6.996, P= 0.001***			

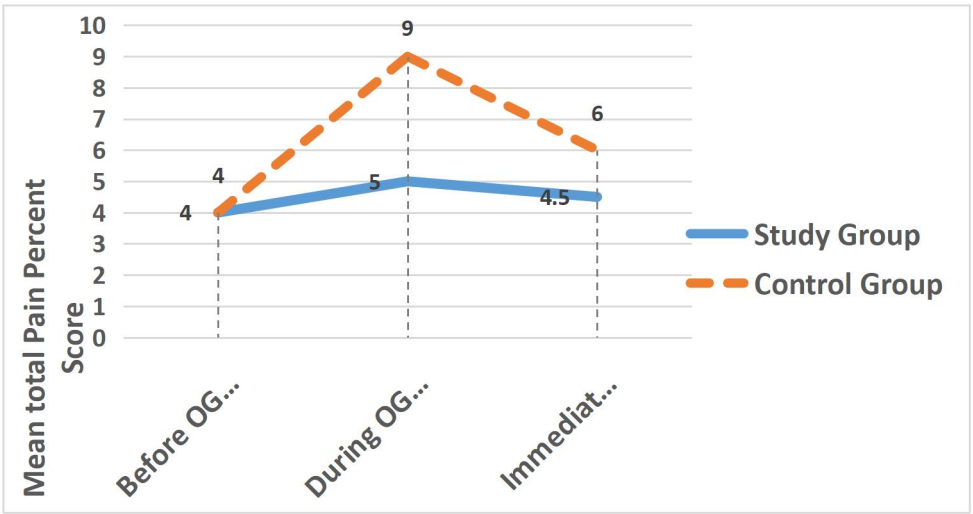

Figure 2: Effect of Mothers' Heartbeats Combined with Swaddling Technique on the Preterm Neonates' Mean Total Pain Percent Score

Discussion

Preterm neonates exposed to various painful procedures through their routine care in the NICU as venipuncture, heel-prick and NG/OG tube insertion (Vinall & Grunau, 2014). Insertion of OGT is necessary to overcome the weakness of neonatal sucking and swallowing. This allows nutrients to be conveyed to their stomach for appropriate growth and development. While OGT insertion is an obligatory intervention, it can stimulate undesirable physiological and behavioral outcomes. Currently, the scientists are ascertained that OGT insertion causes moderate pain (Provenzi et al., 2015; Vinall et al., 2017).

In this context, the AAP advocated the incorporation of pharmacological and non-pharmacological measures for pain management. Developmental supportive care such as swaddling technique and mother-driven interventions as mothers' heartbeats are non-pharmacological methods which are designed to relieve pain of neonates. Such modalities have relaxing and securing effect on preterm neonates (Alemdar & Tüfekci, 2017; Dilek & Güdücü, 2018).

Preterm neonates are critically sensitive to pain due to their vulnerable and immature nervous systems (Williams & Lascelles, 2020). The current study findings reflected that slight to moderate pain during OGT insertion was perceived by half of preterm neonates in the control group and by one fifth of those in the study group. Moreover, sensation of slight to moderate pain immediately after OGT insertion was displayed by nearly one third of preterm neonates in the control group and by 6.7% of those in the study group. These results might be interpreted in the light of the fact that preterm neonates have anatomic and functional requirements for pain processing that are existent early at 20 weeks of gestation that enable them to identify and react automatically to pain (Dezhdar et al., 2016). These findings go consistent with Eckstein (2013) who has conducted a study entitled "pain reaction among very preterm neonates" and concluded that the preterm neonates responded intensively to pain.

In addition, the findings of the current study clarified that there was a statistical significant difference among preterm neonates of both groups regarding mean total pain percent score during and immediately after OGT insertion. These results could be interpreted by the effect of using swaddling technique which restricts preterm neonates' movement or respond spontaneously to pain, which consequently diminishes the number of afferent stimuli in the cerebral cortex, the thalamus, the spinal cord and the tissues resulting in a declined reaction in sympathetic nervous system. Hence, reducing pain and providing relaxation (Stevens et al., 2012).

These results are in congruence with the findings of Karimi et al. (2018) who concluded that swaddling can greatly lessen the pain associated with blood sampling. The findings of Shu et al. (2014) also illustrated that swaddling technique decreased neonatal sensitivity to pain during heel stick. Jebreili et al. (2013) declared that swaddling technique has valuable effect on decreasing pain response among preterm neonates during NGT insertion. Furthermore, Dezhdar et al. (2016) mentioned that the mean PIPP score in swaddled neonates was significantly lower than the neonates in the control group throughout venipuncture.

The current study results also could be justified by hearing mothers' heartbeats had a positive effect which led to neonatal calmness and helped to diminish the stress caused by painful procedure. These results were in accordance with Küçük Alemdar & Güdücü Tüfekcİ (2018) who found that the application of maternal heartbeats intervention successfully decreased pain and offered comfort in relation to aspiration in premature infants. Similar results were reported by Karadag et al. (2022) who tested the effect of simulative heartbeats nest on pain level, vital signs, and comfort in preterm newborns and found that the PIPP total score was decreased, and this reduction was statistically significant after the application of such intervention.

Preterm neonates are incapable to verbally express pain. Nevertheless in response to painful stimuli, a variety of behavioral and physiological reactions such as facial changes, crying, increasing heart rate and respiration, and decreasing oxygen saturation could be noticed among them, which are conclusive evidence of their pain (Rafati et al., 2015). As clarified in the current study findings, during OGT insertion approximately half of the preterm neonates in control group demonstrated an elevation in their heart rates from 5 –14 beats per minute. While, in the study group the majority of preterm neonates had a slight increase in their heart rates from 0-4 beats per minute. There was a statistical significant difference between the both groups. From the researchers' point of view, these results could be related to the effects of swaddling technique combined with mothers' heartbeats, where, tightly wrapping the preterm neonates in a light blanket helped to soothe, console and calm those preterm neonates, take

their mind off the procedure by concentrating on something else that is happening.

Additionally, this result could be interpreted in the light of the fact that the swaddling technique promotes autonomic nervous system response and reduces stress hormones as epinephrine and cortisol combined with control of excessive movement of preterm neonates leading to the stability of heart rate (Dilek & Güdücü, 2018). Moreover, listening to mothers' heartbeats provides relaxing environment similar to that of a womb. This finding is in consistent with Rand & Lahava (2014) who declared that preterm newborns who listened to the recorded mother's voice and heartbeats had a significantly lower heart rate compared to the neonates in control group. Furthermore, Karimi et al. (2018) revealed in their study that the swaddling technique had a positive impact on heart rate stabilization among the study group. On the contrary, Erkut and Yildiz (2017) concluded that the heart rates of swaddled premature neonates were greater than the premature neonates in the control group during heel lance.

Regarding oxygen saturation during OGT insertion, the oxygen desaturation was not detected among the majority of the preterm neonates in study group in comparison with half preterm neonates in the control group. In addition, almost one third of those neonates in the control group experienced slight desaturation i.e, a decline in their oxygen saturation was from 2.5% to 4.9% compared to lowest percentage among the preterm neonates in the study group with a statistical significant difference between the both groups. From the researchers' point of view, these results could be thought that the neonates in the study group had a relaxation response to mothers' heartbeats, which made the neonates calmer, and breathed better which led to an increase in oxygenation. Moreover, the swaddling technique controlled the neonates' movements and prevented overuse of oxygen, leading to more oxygen storage. Moreover, this finding could be attributed to the fact that swaddling technique is a form of sensory stimulation which could increase blood flow to the brain and body tissues, so enhancing oxygen saturation (Hockenberry & Wilson, 2017). This result is corroborated by Salimi et al. (2014) who proved that the swaddled preterm neonates had higher oxygen saturation than the preterm neonates in the control group during NGT insertion.

Pain is a hostile stimulus for all neonates especially preterm. They cannot verbalize their feeling with pain and they express their sensation with cues as facial expressions and behaviors (Ebrahimi et al., 2020; Qiu et al., 2017). The results of the current study declared the behavioral state of the preterm neonates during OGT insertion. Regarding the preterm neonates in the control group, half of them were active sleepers, their eyes were closed and had facial movements compared to nearly half of those in the study group who were quiet sleeper, their eyes were closed and had no facial movements and the difference was statistically significant.

Moreover, the study findings showed that the facial expressions, during OGT insertion for the majority of neonates in the study group demonstrated no brow bulges, nasolabial furrow or eye squeeze. Conversely, more than half of the preterm neonates in the control group exhibited minimum brow bulges, nasolabial furrow and eye squeeze. There was a statistical significant difference between the both groups. These results could be interpreted in the light of the fact that the fetus is able to auditory perception by 29th weeks of gestational age and has the capability to learn and remember auditory stimuli from their mother's womb (Campbell-Yeo et al., 2011). Consequently, listening to mothers' heartbeats which are familiar sounds from the womb would remind them with their secure environment, and this would bring a sense of relief. Besides, swaddling intervention that assisted to limit the neonates' boundaries, promoted self-regulation, and diminished behavioral stress caused by acute pain. Furthermore, the combined effect of non-pharmacological management (mothers' heartbeats and swaddling technique) for pain; they activated the neonates' attention, distracted them from the pain, and thus modified pain perception. In contrast, Stevens et al. (2012) found that preterm neonates exhibited little behavioral responses to pain during the heel stick procedure.

Nowadays, there is exciting evidence that neonates as young as three days after delivery recognize their mothers' voices and heartbeats. Their memory has been displayed to affect physiological and behavioral outcomes and have calming effect (Campbell-Yeo et al., 2011). In this respect, the current study findings clarified that, during OGT insertion 16.7% of preterm neonates in the study group were quiet/awake, their eyes were opened and had no facial movements compared to 6.7 % of those in the control group. On the other hand, only 3.3% of those neonates in the study group were active /awake, their eyes were opened and had facial movements compared to one fifth of the preterm neonates in the control group. From the researchers' point of view, this could be related to providing nearly intrauterine surroundings for the preterm neonates increased their physiological comfort, feelings with security and supported them in directing their energy to cope with stress. In this frame, Webb et al. (2015) stated that the fetus has considerable ability for auditory learning and memory in utero. Additionally, the primary acoustic stimuli the fetus is exposed to before birth is his mother's voice and the sounds of her heartbeats.

Conclusion

Based upon the outcomes of the current study, the preterm neonates who listened to mothers' heartbeats combined with swaddling technique had lower pain score during and even immediately after OGT insertion. Moreover, mothers' heartbeats combined with swaddling technique were effective in enhancing the preterm neonates' behavioral state and oxygen saturation, diminishing the occurrence of preterm neonates' facial changes and increasing in heart rate during and immediately after OGT insertion. This supported our hypothesis that, preterm neonates who listen to mothers' heartbeats combined with swaddling technique had lower pain score during OGT insertion than those who do not.

Recommendations

Based upon the findings of the current study, the following recommendations are suggested:

- Pre-service training for newly recruited nurses and educational programs for neonatal nurses about neonatal pain assessment and non-pharmacological interventions particularly mothers' heartbeats combined with swaddling technique should be carried out on a regular basis to improve their pain management skills among preterm neonates.
- Non-pharmacological interventions for neonatal pain relieve especially mothers' heartbeats combined with swaddling technique should be incorporated in the NICU policies and the written guidelines concerning painful procedures.

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