

Kangaroo Mother Care Alleviates Neonatal Pain From Adhesive Tape Removal: A Randomized Controlled Trial Among Preterm Neonates

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Abstract

Background: Kangaroo Mother Care (KMC) is a non pharmacologic method used to alleviate neonatal pain from minor medical procedures. This study measured the effects of short duration kangaroo Mother Care on neonatal pain from adhesive tape removal among preterm neonates.

Method: Superiority randomized controlled trial was conducted among 156 preterm neonates. Neonates assigned in intervention group received ten minutes of KMC before adhesive tape removal while neonates in control group remained in the incubators. Neonatal pain was measured using premature infant pain profile. Paired and independent samples *t*-tests were used to compare the pain of the neonates before and during adhesive tape removal.

Result: Seventy seven (49.4%) of the participants were males. Their average gestational and postnatal age was 33.8(1.8) weeks and 5.1(2.4 to 8) days respectively. The neonates spent 5.08 (2.42 to 8.04) days in health institutions before the time of data collection and 56 (35.9%) of them were critically ill during admission. Neonates assigned in KMC group had significantly lower pain than the control group [Mean difference= -2.5, 95% CI (-3.9, -1.2), *P*<0.001]. Though, KMC was able to reduce the behavioral responses of pain, its effect on physiologic pain responses was not significant.

Conclusion: Ten minutes of kangaroo mother care can reduce pain from adhesive tape removal among preterm neonates. Yet, further studies needs to be done to determine the feasibility routine KMC utilization for neonatal pain management in low income countries.

Keywords : Kangaroo mother care, neonatal pain, adhesive tape, preterm neonates, Tikur Anbessa Referral Hospital, Gandhi Memorial Hospital

Trial registration: PACTR202009770590788

Back ground

The International Association for the Study of Pain has defined pain as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage” (Anand & Craig, (n.d)). KMC is a continuous and prolonged skin to skin contact between the baby and the mother (World Health Organization [WHO], 2003). It is recommended for preterm neonates born in low income settings mainly to prevent hypothermia and improve weight gain (World Health Organization [WHO], 2015). In Ethiopia, Tikur Anbessa Specialized Hospital (TASH) started to provide KMC in 1996 (Save the Children, 2017). By 2015, the national newborn and child survival strategy targeted to

boost KMC coverage from 10% to 90% by 2020 (Federal Ministry of Health [FMOH], 2015).

In neonatal intensive care units (NICUs), it is difficult to prolong the lives of preterm neonates without performing different painful medical procedures. However, much can be done to lessen their suffering. Yet, 80% to 99 % of painful procedures are conducting without proper management (Ce'leste Johnston et al., 2010; World Health Organization [WHO], 2012; Lake, 2013). Being exposed to painful procedures during early life is associated with altered brain and hormonal functions as well as disrupted stress response in later life (Hall, 2005; Fitzgerald, 2014; Whitfield, 2004; Brummelte, et al., (n.d); Sam M. Doesburga, 2013). Preterm neonates are even more vulnerable to complications resulted from pain inducing procedures due to

their immature pain modulation system (Hall, 2005; Whitfield, 2004; Page, 2004). Due to this, it is recommended to consider neonatal pain management as the “fifth vital sign”.

Previous studies showed that short duration of KMC can reduce neonatal pain from various painful medical procedures. A meta-analysis of 25 studies indicated that KMC is an effective and safe means of reducing neonatal pain from a single painful procedure (Johnston C et al., 2017). On the other hand, a single study showed that KMC was able to effectively relieve neonatal pain from three consecutive heel lances compared to that of the incubator care (Haixia Gao et al., 2015).

However, similar studies were not conducted in lower income countries like Ethiopia. Assuming the differences in the NICUs of higher and lower income settings, this study examined the effects of short duration of KMC on neonatal pain from adhesive tape removal among preterm neonates admitted to TASH and Gandhi Memorial Hospital (GMH) in Addis Ababa, Ethiopia. By examining the pain relieving effects of KMC in one of the lower income countries, this study is expected to add a piece of scientific evidence on the already existing knowledge.

Methods

Study design and setting

An open label, pragmatic, parallel, superiority randomized controlled trial (RCT) study was conducted from May-October, 2018. TASH and GMH are governmental hospitals located in Addis Ababa. TASH is the largest referral hospital in Ethiopia and a year before the study was initiated, 4,479 neonates were admitted to its NICU. Among those neonates, 189 (4.2%) of them were admitted due to prematurity. On the other hand, GMH is known for its maternal and child health services. In 2016/17, 2,358 neonates were admitted to the neonatology unit of which 4.6% (108) of them were preterm neonates.

Sample size determination

The sample size of the study was determined using Stata 14.0 based on a data obtained from a pilot study conducted by Nanavati and associates (RUCHI et al., 2013). The sample size to detect a mean difference (MD) of 1.5 points in premature infant pain profile (PIPP) scores standard deviation (SD)=2.59 with a power of 90%, alpha of 5% and 25% attrition rate was estimated to be 160. Though a MD of 2 points in PIPP scores among the groups was considered as a clinically important difference, a MD of 1.5 was used to increase the power of the study.

Recruitment

The neonates were included in the study if they were born between 28 and 36 completed weeks of gestation, were not on continuous positive air way pressure (CPAP) or prong oxygen therapy and had mothers capable of providing KMC. Preterm neonates who had visible or diagnosed congenital and neurological anomalies, were diagnosed with subgaleal or intraventricular hemorrhage, went through surgery or begun the continuous type of KMC before the time of data collection were excluded from the study.

Block randomization with block sizes of 4 and 6 was used alternatively to assign the neonates to one of the study groups using numerical sequences generated online at <https://www.random.org>. Until the mothers of the neonates gave informed consent, the randomization sequence was kept concealed using sequentially numbered sealed opaque envelopes technique. The random numbers were generated and sealed by the investigator of the study who had no direct contact with the study participants.

Intervention of the study

For those neonates in the intervention group, KMC was provided ten minutes before adhesive tape removal as an intervention to relieve pain. Once the group of the neonate was identified, the mother was asked to sit on one of the chairs available inside of the NICUs. Then, the nurse took the neonate from the incubator and placed him/her on the mother's bare chest between her breasts in upright position while his/her head was slightly extended to facilitate breathing. His/her legs were positioned below the mothers' breasts wide opened and flexed and the his/her back is wrapped with additional cloth up to his/her ear level to prevent heat loss. During the contact the mother is allowed to talk, move or do other activities with her neonate. However, she is not allowed to feed her baby. Once the comfort of the neonate and the mother is assured, this position is maintained for ten minutes before the adhesive tape removal. By the end of ten minutes the nurse who is responsible for the removal of the adhesive tape began to record the behavioral state of the neonate by observing his/her face for about 15 seconds. The duration of the KMC was recorded by using of Square Clock DS-510 adjusted to “beep” at the end of ten minutes. After, a pulse oximeter is placed on the feet of the neonate the baseline heart rate (HR) and oxygen (O₂) saturation were measured. Then, the nurse removed the adhesive tape while the baby was in KMC position. Following the removal of the plaster, the neonate's face is observed for about 30 seconds and the behavioral and physiologic component of the PIPP tool is recorded. The HR and O₂ saturation of the neonates were measured using pulse oximeters manufactured by Infiniti Medlab Pvt. Ltd (India). Once the data collection is completed, the KMC is continued or ceased immediately depending on the mother's need.

Control group

For those neonates assigned in the control group, the adhesive tape was removed while they were in the incubators as this was the standard care in the selected hospitals. Whenever adhesive tape was needed to be removed, the data collector nurse recorded their behavioral state while the neonate is placed inside of the incubator. Then pulse oximeter is placed on his/her feet and baseline HR and O₂saturation are measured. Once the baseline parameters are recorded, the plaster is removed. Following the removal the neonate's face is observed for about 30 seconds and the behavioral and physiologic components of the PIPP tool are recorded.

Study measures

The outcome of the study was neonatal pain during adhesive

tape removal was measured by PIPP scale. PIPP scale is developed by Stevens et al in 1996 and its use in clinical settings was validated in different studies (Stevens et al., 1996). The PIPP scale has seven indicators which are classified in to contextual factor indicators (gestational age (GA) and behavioral state), physiologic pain indicators (HR and O2 saturation) and behavioral pain indicators (brow bulge, eye squeeze and naso-labial furrow) (Stevens et al., 1996).The pain level was scored out of 21 and a 2 point difference in the score was considered as clinically significant difference (Stevens et al., 1996).

Severity of illness: the neonates were considered as critically ill if they had apnea, breathing rate less than 40 breaths per minute (BPM), breathing rate greater than 60 BPM, intercostal/subcostal retraction, chest indrawing or grunting during admission plus history of CPAP oxygen therapy.

Ethical consideration

The data collection process was initiated after permission was obtained from College of Health Sciences, Addis Ababa University and the study hospitals. The eligible study participants were enrolled in the study only after their mothers voluntarily gave written informed consent. The adhesive tape

removal was conducted as part of routine clinical procedures and was not intended for this study purpose. The information regarding the study participants was kept confidential by using specific identification code for each of them.

Statistical analysis

The data was entered into Epi data version 3.1 to minimize errors during entry and exported to Stata 14.0 for cleaning, editing and analysis. During the analysis of the outcome variable the study, the principle of intention to treat analysis (ITT) was used. The normality of the continuous variables was checked by using histogram. Descriptive statistics were used to describe the findings of the study. Parametric tests were used for normally distributed variables while non-parametric tests were used for non-normally distributed variables.

Result

During the data collection period 184 preterm neonates were admitted to the study hospitals and screened for eligibility. Among those neonates 160 of them fulfilled the inclusion criteria of the study and the mothers of 156 neonates agreed to participate in the study. There was no lost to follow up during the time of data collection (Figure 1).

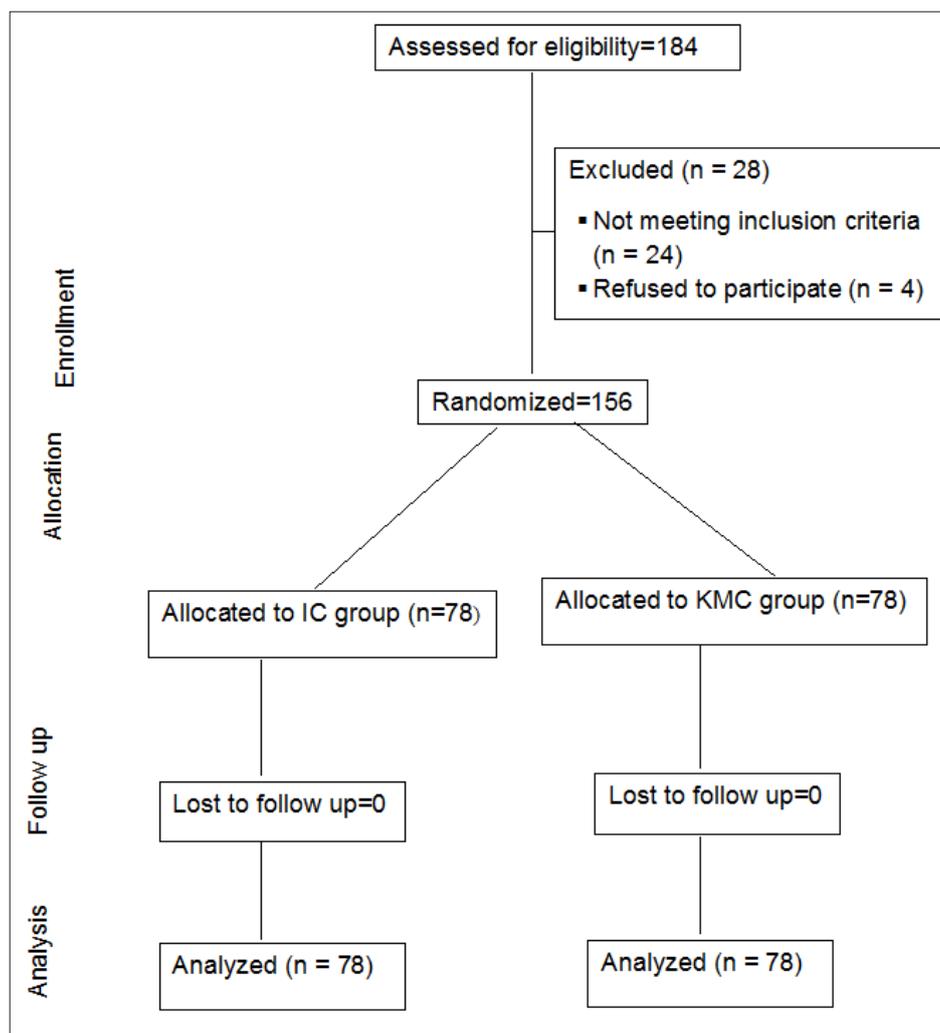


Figure 1: CONSORT flowchart of the study participants

Among those neonates involved in the study 77(49.4%) of them were males. The mean GA of the study participants was 33.8±1.8 weeks while their median postnatal age (PA) was 5.1(2.4 to 8) days. Thirty four (21.9%) of the neonates had previous KMC experience before they were recruited for the study (Table 1).

Variables	KMC (n=78)	IC (n=78)	P-value
Sex, n (%)			0.26
Male	42(53.9)	35(44.9)	
GA(weeks) †	33.8 (1.9)	33.7 (1.6)	0.88
PA(days)	5.2 (3 to 8.3)	5.1 (2 to 7.2)	0.49
Mode of delivery, n (%)*			
Spontaneous vaginal delivery	48(62.3)	43(55.1)	0.36
Cesarean section	29(37.7)	35(44.9)	
5 th minute Apgar score*	8(7 to 9)	8(7 to 9)	0.44
Birth weight(gm) †	1792.2(380.9)	1696.5(376.2)	0.12
Hours passed between last feeding and time of data collection (hrs.)*	1.3 (0.5 to 2)	1.2(0.5 to 2)	0.49
LOS in health institutions (days)*	5.1(3.0 to 8.3)	5.1 (2 to 7.3)	0.44
Critically ill during admission, n (%)	24(30.8)	32 (41)	0.18
Neonates on INO ₂ support during data collection, n (%)	9(16.7)	13(25.5)	0.27
Neonates who had previous KMC experience, n (%)*	22(28.2)	12(15.6)	0.06

[* missed values, † values in terms of mean (SD), LOS= Length of stay]

Table 1: Demographic and medical characteristics of the study participants

Preterm neonates recruited as study participants spent 5.08 (2.42 to 8.04) days in health institutions before the time of data collection and 56 (35.9%) of them were critically ill during admission. One hundred five neonates (67.3%) had been treated with O₂ for about 4(2 to 6.63) days. During the time of data collection, 22 (20.9%) of them were on intranasal oxygen (INO₂) support (Table 2).

Variables, n (%)	KMC (n=78)	IC (n=78)	P-value
Blood draw			
Once	40(51.3)	43(55.1)	0.67
More than once	4(5.1)	2(2.6)	
IV cannula insertion			
Once	23(29.5)	21(26.9)	0.53
More than once	5 (6.4)	9(11.5)	
NGT insertion			
Once	18 (23.1)	13(16.7)	0.44
More than once	4(5.1)	7(8.9)	
Heel prick			
Once	2 (2.6)	4(5.1)	0.44
More than once	0	1(1.3)	
Lumbar puncture			
Once	1(1.3)	0	1

(Multiple responses were possible) [IV= Intravenous, NGT= Nasogastric tube]

Table 2: Previous painful medical procedures conducted on the study participants

One hundred forty six (93.6%) neonates [KMC group=72(92.3%) and IC group=74(94.9%), $P=0.51$] were exposed to at least one painful medical procedure before the time of data collection. None of the preterm neonates recruited for this study had received analgesic drugs at least for 24 hours before the data collection.

In both hospitals heuer zinc oxide cloth plaster manufactured by GST Corporation Ltd (India) was used to conduct different procedures. Additionally in GMH, ReliaMed® paper surgical tape manufactured by ReliaMed® (China) was used during minor procedures like nasogastric tube (NGT) insertion. For 132 (84.6%) participants cloth plaster was removed while paper plaster was removed for the rest of the neonates.

The responses of preterm neonates during adhesive tape removal

The average baseline PIPP score of the study participants was 4±3.4 and there was no statistically significant difference between the groups [KMC=3.9±3.6, IC group= 4.1±3.3, $p=0.79$]. The average baseline HR of the neonates was 139.7±17.3beats per minute (bpm) [KMC=139.4±15.9bpm, IC=139.9±18.7bpm, $P=0.82$] and their baseline oxygen saturation was 94% (91 to 96) [KMC= 94% (92 to 96), IC= 94% (91 to 96), $P=0.79$].

A paired samples t-test indicated that, the PIPP score of the preterm neonates assigned in both groups during adhesive tape removal was significantly increased compared to their baseline state [MD=5.1, 95% CI (4.4, 5.8), $P<0.00$]. It also indicated that the actual HR of preterm neonates recruited for the study was significantly increased during the time of tape removal compared to their baseline state [MD=7.8bpm, 95% CI (5.6, 9.9), $P<0.00$]. However, the O₂ saturation of the neonates during adhesive tape removal was not significantly

different from level of oxygen saturation before the adhesive tape removal (P=0.26).

The effects of KMC on neonatal pain during adhesive tape removal

The independent samples t-test showed that preterm neonates in KMC group had lower PIPP scores during adhesive tape removal than that of the neonates kept in the incubator [MD=-2.5, 95% CI (-3.9, -1.2), P<0.00](Table 3). Also, compared to their baseline state, the average increment in the PIPP score of neonates in KMC group [MD=7.4, 95% CI (4.7, 10.2), (P<0.00)] was lower than that of the neonates in the incubator group [MD=8.1, 95% CI (4.6, 11.5), (P<0.00)].

Though the actual HR of neonates assigned in KMC group during adhesive tape removal was lower than that of the neonates in the incubator group, the difference was not statistically significant [MD= -1.3, 95% CI (-7.8, 5.2), P=0.69] (Table 3). Also, the study participants in KMC group had lower actual oxygen saturation compared to the oxygen saturation of participants in the incubator group. However, the difference was not statistically significant (P=0.83) (Table 3).

Variables	KMC(n=78)	IC(n=78)	M D (95%CI)	P-value
P I P P score*¥	7.8(4.2)	10.3(4.2)	- 2 . 5 (- 3 . 9 , -1.2)	0.00
Scores for PIPP tool components				
GA	1(1)	1(1)		0.55
Alertness state	2(1 to 2)	2(1 to 3)		0.82
B r o w bulge	1(0 to 2)	2.5 (1 to 3)		0.00
E y e squeeze	1.5(0 to 3)	2(1 to 3)		0.02
Nasolabial furrow	1.5(0 to 2)	2(1 to 3)		0.00
Heart rate*	1(0to 2)	1(0 to 2)		0.72
O x y g e n saturation*	0(0 to 1)	0(0 to 1)		0.42
Actual HR (bpm)*¥	146.5 (17.4)	148.1(22.8)	- 1 . 3 (- 7.8, 5.2)	0.69
A c t u a l o x y g e n saturation (%)*	93(91 to 96)	94(91 to 95)		0.83

[* Missed values (n=5), ¥ values in mean (SD), bpm (beats per minute)]

No adverse effect was reported among preterm neonates participated in the study.

Table 3: The PIPP scores of the study participants during adhesive tape removal

Discussion

A parallel RCT study was conducted among 156 preterm neonates born between 28 and 36 weeks of gestation to determine the effects of short duration KMC on neonatal pain from adhesive tape removal. Our study showed that, initiation of KMC ten minutes before adhesive tape removal had both clinically and statistically significant pain reducing effect among preterm neonates. This finding was in accordance with the previous studies which showed that preterm neonates treated with various duration of KMC during different painful medical procedures had significantly lower PIPP scores compared to neonates kept in incubator (Shahin Dezhdar et al., 2016; Akcan et al., 2009; C Celeste Johnston et al., 2008).

The findings of this study should be interpreted with caution due to its limitations. Though strict follow up was made, biases might be introduced to the study due to lack of blinding. Since we did not use standard tools to determine the severity of illness, there might be misclassification of cases. Moreover, the magnitude of previous painful procedures might be under estimated since we only assess for painful procedures that were conducted on the neonates 24 hours before the initiation of data collection. Despite of its limitations, however, our study was powered enough to detect minimal group differences and used a validated neonatal pain measurement tool.

In our study, the behavioral indices of pain were found to be lesser among neonates in KMC group. This finding was important since those behavioral actions have higher sensitivity and specificity for neonatal pain. This finding was supplemented by different studies that were conducted previously. T.C Casteral showed that preterm neonates in KMC group had lower facial expressions than neonates in the incubator throughout the whole phases of heel prick (Thaila C. Castral et al., 2008). Moreover, the studies by Ludington-Hoe and Hosseini, Kostandy et al and H.Gao et al showed that preterm neonates exposed to KMC of various durations had lesser crying and grimace (Haixia Gao et al., 2015; Ludington-Hoe & Hosseini, 2005; Raouth Kostandy, 2008).

The lack of significant group differences in HR and oxygen saturation of the study participants during adhesive tape removal was in line with the study of T.C Casteral (Thaila C et al., 2008). In contrast, Ludington-Hoe and Hosseini and H.Gao et al showed that during heel prick, the HR of preterm neonates in KMC group was significantly lower than that of the control group (Haixia Gao et al., 2015; Ludington-Hoe & Hosseini, 2005). These inconsistencies might be caused by different reasons. The first possible reason could be the weak correlation between behavioral and physiologic pain indicators. Behavioral responses are “overt” responses that newborns used to communicate and alarm their caregivers whenever they are in need of help (Barr, 1998). On the other hand, physiologic pain responses are “covert” responses which cannot be easily detected by caregivers (Barr, 1998). Due to this reason the two types of pain responses are loosely correlated or might not be correlated at all (Barr, 1998). Yet, their correlation might gets increased as the intensity of the pain increased (Van Dijk et

al., 2001). In this case, the intensity of pain during adhesive removal might not be large enough to cause strong correlation between the behavioral and physiologic pain responses. The other reason might be the measurements of HR and oxygen saturation in the current study might be affected by the fact that some of the neonates were receiving intranasal oxygen support during data collection. Another justification could be the fact that the sample size of this study was determined to detect clinically and statistically significant difference in composite PIPP score, it might not be powered enough to specifically detect significant differences in HR and oxygen saturation of the neonates.

KMC reduce neonatal pain through sensory saturation and increment of oxytocin secretion. Oxytocin in turn increases the level of beta-endorphin and activation of c-afferent nerves which have analgesic effect. In addition to this, continuous, warm and pleasant human touch in case of KMC activates c-afferent nerves located on the chest of the neonates that are important for anxiety reduction (Ludington-Hoe, 2015). Oxytocin and c-afferent nerves are also important for physiologic stability.

Proper neonatal pain management is one way of supporting preterm neonates to make it through the harsh environment of NICUs. Previous studies showed that KMC reduce pain for those preterm neonates exposed to heel lance. Our study also provided additional evidence on the pain alleviating effects of KMC among preterm neonates during adhesive tape removal. During painful events, preterm neonates do not only need analgesics but also the reassuring presence of their mothers. KMC is the best way of letting the neonates to know that their mothers are on their side. Thus, it is recommended for health care providers to support and encourage mothers to comfort their neonates during painful events. So far, different researches have been conducted to examine the effects of KMC on neonatal pain responses and promising results have been reported. However, it will be interesting if future studies focus on critically ill preterm neonates and also examine the duration of KMC that can optimally benefit them.

Conclusion

In this study, we have showed that ten minutes of KMC can reduce neonatal pain from adhesive tape removal and preterm neonates born between 28 and 36 completed weeks of gestation can be benefited from it. Yet, more researches need to be conducted to determine the pros and cons of using KMC for neonatal pain management among low income countries.

What is already known on this topic?

- Kangaroo mother care is a safe technique to reduce pain from minor clinical procedures among preterm neonates
- The effects of kangaroo mother care on physiologic pain responses might not be large

What this study adds?

- Our study was the first to be conducted in low income countries' setting which is different from the previous studies. Thus, it will add a piece of evidence on the

existing scientific knowledge.

- Ten minutes of kangaroo mother care can reduce neonatal pain from adhesive pain removal among preterm neonates.

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Competing of interest

The authors declare that they have no competing interests

Author's contributions

YBB was involved in all stages of the study. ASE and WMA involved in protocol development, data analysis and interpretation and critically review the manuscript. AD and MMM were involved in training of data collectors, randomizing of participants and manuscript development.

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