

ORIGINAL RESEARCH

Role of sucrose, pacifier and their combination as pain reliever among preterm neonates during painful procedures

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ABSTRACT

Background/Objective: The role of sucrose and/or non-nutritive sucking (NNS) has been evaluated for relieving procedural pain in newborn infants with satisfactory results however there was a controversy regarding the synergistic effect of their combination.

Methods: This quasi-experimental study was conducted in the neonatal intensive care unit in Assiut University Children Hospital including 120 preterm neonates who were divided into 4 groups (20 neonates each). Control group received routine hospital care; sucrose group received oral sucrose solution (OS); pacifier group received pacifier; and last group received oral sucrose solution and pacifier during painful procedures. All were assessed regarding socio-demographic and clinical data in addition to application of Premature Infant Pain Profile (PIPP) scale to assess the levels of pain and mean pain scores pre and post-intervention.

Results: The 4 groups were similar regarding socio-demographic and clinical data. The application of the OS and/or pacifier, led to significant improvement of the levels of pain and reduction of the mean score of pain among preterm neonates during painful procedures. In addition, combined pacifier and OS was superior to OS alone and comparable to pacifier alone regarding their effect on the reduction of pain level and mean score of pain.

Conclusions: OS and pacifier are effective as pain reliever during painful procedures among preterm neonates. Combined OS and pacifier is superior to OS and pacifier alone.

Key Words: Sucrose, Pacifier, Neonatal intensive care unit, Preterm neonates, Pain relief, Painful procedures

1. INTRODUCTION

Pain among neonates may be attributed to several causes as frequent heel sticks for blood withdrawal, invasive procedures and others.^[1] The pain assessment among neonates is a difficult issue due to the inability of the neonates to express verbally. Accordingly, the accompanying physiological and behavioural changes following exposure of neonates to pain are the bases of most pain assessment scales that can be

recognized by health care specialists. When the pain in the neonates is not managed adequately, mortality and morbidity are increased in addition to the possible adverse effects on the development.^[2]

The neonates are more liable to the harmful effects of pain when compared to older children because of the immaturity of the nervous system which make the pain experience more enhanced and prolonged.^[3] It is estimated that, in neonatal

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intensive care unit (NICU), neonates are subjected to more or less than 14 painful procedures mostly in the 1st day; the majority of them are venipuncture and heellance.^[4]

Considering the long lasting consequences of undertreated procedural pain among preterm neonates, it has been suggested that, adequate treatment of procedural pain during the first week of life has a long term positive developmental impacts.^[5] In addition, repeated exposure of the neonates to procedural pain early in their life is considered to be remembered and increased sensitivity to pain may continue into childhood or even lifetime.^[6]

The well documented analgesic effect of oral sucrose (OS) in preterm and term infants can be explained by the indirect evidence of endogenous opioid mediation where its activation by oral sucrose decreases interpretation of pain information at the dorsal horn level.^[7] This is supported by the finding that, naloxone administration as an opioid antagonist suppressed the analgesic effect of oral sucrose.^[8]

It is well known that, non nutritive sucking (NNS) is an innate intrauterine activity of the fetus that facilitates their adaptation to the surrounding environment. Accordingly pacifier was investigated as a method for pain relief. Therefore, neonatal nurses considered pacifier a first choice as pain reliever among neonates based on being easy with quick onset and short duration of action in addition to being inexpensive and with no hazards.^[9]

In a study conducted by Andersen et al. (2007), they concluded that, clinical staff in Norwegian NICU reported that, procedural pain in neonates is not sufficiently managed and the use of pharmacological and non pharmacological methods were suboptimal.^[3]

Due to the conflicting results regarding the synergistic effect of both OS and NNS in pain relief during painful procedures among neonates and scarcity of studies including the subject in our locality, we designed this study to clarify the situation regarding this point of interest.

1.1 Significance of the study

The old concept that, preterm neonates have low feeling of pain based on the immature central nervous system is canceled.^[10] Actually they have normal pain feeling because all the neurological structures essential for sensation of pain are developed by the 24th weeks of intrauterine life.^[11] In addition, repeated exposure to painful stimuli may affect infants' physiological processes and lead to changes in pain sensitivity leading to low pain threshold and feeling of pain even when exposed to other care such as handling.^[12]

Unadequately treated procedural pain among preterm

neonates may lead to several short term consequences as hyperglycemia, decreased oxygen saturation, tachycardia, decreased pain threshold and long term effects as cognitive deficits, problem related to learning and motor performance in addition to attention deficits.^[10]

Parents of preterm neonates usually depend on nurses to protect their neonates from unneeded pain exposure. Therefore, they consider nurses safeguard for their preterm neonates. So nurses have the major responsibility of pain management and promotion of neonates well-being.^[13]

The investigator when working as a staff nurse in a pediatric hospital has experienced that, the neonates exposed to painful procedures are often neglected and managed without any intervention. This has motivated the investigator to conduct this study so as to find out the effectiveness of OS and/or pacifier in pain management among them. In addition, this study was not conducted before in our locality in South Egypt.

1.2 Aim of the study

To evaluate the efficacy of oral sucrose, pacifier and their combination on pain relive among preterm during painful procedures.

2. MATERIALS AND METHOD

2.1 Research design

A quasi-experimental research design was used to conduct this study.

2.2 Setting

This study was conducted in the NICU at Assiut University Children Hospital.

2.3 Subjects

The study included a convenient sample of 120 preterm neonates who were selected from the previous setting. They were randomly divided into four groups: control group: included 30 preterm neonates who received routine hospital care; sucrose group: included 30 preterm neonates who received oral sucrose solution prior to painful procedures; pacifier group: included 30 preterm neonates who received NNS (pacifier) prior to painful procedures; pacifier and sucrose group: included 30 preterm neonates who received pacifier and oral sucrose solution prior to painful procedures.

2.4 Inclusion criteria

This study included preterm neonates of both sex who were hospitalized in NICU with gestational age less than 37 weeks and were subjected to painful procedure such as heellances and venipuncture.

2.5 Exclusion criteria

Preterm neonates with severe medical problems or surgical congenital anomalies, those taking nothing by mouth for any reason, those with hyperglycemia and those who received analgesia or sedation within 12 hours prior to data collection were excluded from the study sample.

2.6 Tools of the study

This study included two tools.

Tool I: Assessment sheet of preterm neonates: The researchers designed this sheet after reviewing the relevant literatures and consisted of: demographic and clinical data of preterm neonates such as gestational age, birth weight, current weight, gender, postnatal age, type of delivery and medical history. The validity of the questionnaire sheet was tested by 5 experts in the pediatric field where its value was 0.93 and the needed modifications were done accordingly. Cronbach's alpha test was used to evaluate the reliability of questionnaire sheet and found to be 0.86.

Tool II: Premature Infant Pain Profile (PIPP) scale: To assess pain profile among preterm neonates. It consisted of 7 indicators: 3 indicators of facial actions: naso-labial furrow, eye squeeze and brow bulge; 2 physiologic indicators: changes of oxygen saturation and heart rate; in addition to gestational age and behavioral state of neonate pain. It included four point pain scale: 0,1,2,3. Scoring system is graded as follows: 0 = no pain; 7 = mild pain; 14 = moderate pain and 21 = worst pain.^[14] Reliability of tool II was assessed in previous study done by Elserafy et al. (2009) and its value was found to be 0.97.^[18]

2.7 Method of data collection

Official Permission was obtained from the director of the Neonatal Intensive Care Unit in Assiut University Children Hospital. A pilot study was carried out involving 12 children (3 of each group) to test the feasibility and applicability of the tools. Necessary modifications were done and they were excluded from the sample. The pain was assessed using PIPP. Pulse oximetry was used to measure the baseline heart rate and oxygen saturation of the infant. The gestational age of the infant was scored on a 4-point scale. A research assistant who was blind regarding study purposes assessed each facial action as present or absent for the first 30 seconds for the venipuncture and 20 seconds for intramuscular injection and heellances. After that, the neonate was observed for 15 seconds for scoring of the behavioral state being active, awake, quite or sleep. Also, the neonate was observed for 30 seconds to calculate the maximum increase in heart rate and the minimum decrease in oxygen saturation. The total PIPP scores were calculated for each procedure by summing the

scores of the 7 indicators. The intraclass correlation coefficient was 0.97. The preterm neonates in the sucrose group were given 0.5 ml of 24% sucrose, the tip of a 1 ml syringe without the needle was placed in the mouth and the solution is given with easy movement of the syringe to stimulate sucking for 30 seconds, each treatment was given 2 minutes before the procedure and the net result was the assessment of pain induced by painful procedure. The preterm neonates in pacifier group were given pacifiers with standard nipple which held gently in the mouth for 2 minutes before and throughout the procedure. Usually every neonate used a new pacifier. The preterm neonates in pacifier and sucrose group were given pacifier dipped with the sucrose solutions into the mouth for 2 minutes before the procedure. The procedural pain was assessed by the researcher immediately after painful procedures using the PIPP scale.

2.8 Ethical considerations

The Ethical Committee of Faculty of Nursing, Assiut University approved the research proposal. An informed consent was obtained from parents of participating neonates after explaining the nature and purpose of the study. The parents had the right to refuse to participate or withdraw from the study without any rational any time. Both confidentiality and anonymity were assured.

2.9 Statistical analysis

The data was analyzed using SPSS version 19 (Statistical Package of Social Sciences) after being collected and entered. The presentation of data was in the form of number, percentage, mean and standard deviation (SD). Chi-square test was used for qualitative variables. Comparison between two groups regarding quantitative variables was done using Mann-Whitney-U and ANOVA test was used for comparison of more than 2 groups. p -value of $< .05$ was considered statistically significant.

3. RESULTS

Table 1 shows that the preterm infants of the 4 groups were comparable regarding the gestational age, gender, birth weight, postnatal age and current weight.

Table 2 and Figure 1 illustrate the effect of the interventional methods; pacifier, sucrose and both on the level of pain during painful procedures in comparison to the control group. The baseline data of the pain levels were comparable in the 4 groups before intervention ($p = .608$). After application of the different interventional methods (oral sucrose, pacifier and both), there were highly significant improvement of the levels of pain among preterm neonates during invasive procedures with variable percentages ($p < .001$) in compar-

ison to control groups. There was no severe pain with the three interventional methods. The percentages of mild level of pain increased from 6.7% among control group to 80% in the pacifier group, 73% among sucrose group and 93%

among pacifier and sucrose group. Similarly the percentages of moderate level of pain reduced significantly among the infants of pacifier and sucrose group in comparison to the control (6.7% vs. 26.7% respectively).

Table 1. Socio-demographic characteristics of children in control and study groups

Variable	Categories	Control Group (n = 30)	Pacifier (n = 30)	Sucrose (n = 30)	Pacifier and Sucrose (n = 30)
Age (years)	< 28 weeks	3 (10%)	6 (20%)	5 (16.7%)	4 (13.3%)
	28 weeks	4 (13.3%)	9 (30%)	6 (20%)	6 (20%)
	32 weeks	11 (36.7%)	6 (20%)	8 (26.7%)	11 (36.7%)
	36 weeks & more	12 (40%)	9 (30%)	11 (36.7)	9 (30%)
	Range	28-36	27-36	27-37	26-36
	Mean ± SD	33.47 ± 2.73	32.2 ± 3.37	32.8 ± 3.29	33.07 ± 3.18
Sex	Male	18 (60%)	21 (70%)	15 (50%)	18 (60%)
	Female	12 (40%)	9 (30%)	15 (50%)	12 (40%)
Birth wight	< 1,500g	3 (10%)	0	7 (23.3%)	3 (10%)
	1,500 g - < 2,500 g	25 (83.3%)	28 (93.3%)	20 (66.7%)	25 (83.3%)
	2,500 g and more	2 (6.7%)	2 (6.7%)	3 (10%)	2 (6.7%)
	Range	0.7-2.7	0.8-2.9	0.8-2.8	0.8-2.7
	Mean ± SD	1.19 ± 0.5	1.14 ± 0.47	1.39 ± 0.61	1.16 ± 0.49
Post natal age	1 Day	17 (56.7%)	12 (40%)	6 (20%)	12 (40%)
	3 Day	5 (16.7%)	10 (33.3%)	15 (50%)	9 (30%)
	6 Day& more	8 (26.7%)	8 (26.7%)	9 (30%)	9 (30%)
	Range	1-8	1.5-9	1.5-8	1.5-9
	Mean ± SD	3.25 ± 2.64	4.42 ± 2.47	4.55 ± 1.74	4.62 ± 2.66
Current Wight	Range	1.1-5.53	1.28-5.53	1.1-3.57	1.79-3.76
	Mean ± SD	2.91 ± 0.99	3.06 ± 1.03	2.6 ± 0.81	2.9 ± 0.51

Note. Data are expressed as number (%).

Table 2. Comparison between the interventional methods (pacifier, sucrose, pacifier and sucrose) and control regarding the effect on the pain level

Variable	Categories	Control Group n (%)	Pacifier n (%)	Sucrose n (%)	Pacifier and Sucrose n (%)	p value
Pre-Intervention						
Pain Level	Mild	2 (6.7%)	2 (6.7%)	1 (3.3%)	0	.608
	Moderate	8 (26.7%)	10 (33.3%)	12 (40%)	14 (46.7%)	
	Severe	20 (66.7%)	18 (60%)	17 (56.7%)	16 (53.3%)	
	Mean ± SD	14.1 ± 3.6	13.93 ± 3.62	13.93 ± 3.5	13.93 ± 3.36	
Post-Intervention						
Pain Level	Mild	2 (6.7%)	24 (80%)	22 (73.3%)	28 (93.3%)	< .001**
	Moderate	8 (26.7%)	6 (20%)	8 (26.7%)	2 (6.7%)	
	Severe	20 (66.7%)	0	0	0	
	Mean ± SD	14.1 ± 3.6	6.57 ± 2.6	7.63 ± 1.99	5.37 ± 2.13	

Note. Chi-square test, **Significant difference at p value < .01.

Table 3 shows the comparison among study groups in addition to group by group comparison regarding the effect on the level of pain among preterm infants during painful procedures. There were significant reduction of the mean score of pain among infants after the application of the three

interventional methods in comparison to control (p < .001). Regarding the comparisons between the three interventional methods, pacifier and sucrose was superior to sucrose alone (p = .001) and comparable to pacifier alone (p = .083). Also sucrose alone was comparable to pacifier alone (p = .123)

regarding their effect on the reduction of pain level. When the mean scores of pain post-intervention in the different study groups were compared to the different items of demo-

graphic data including gestational age, gender, birth weight, postnatal age, no significant differences were found.

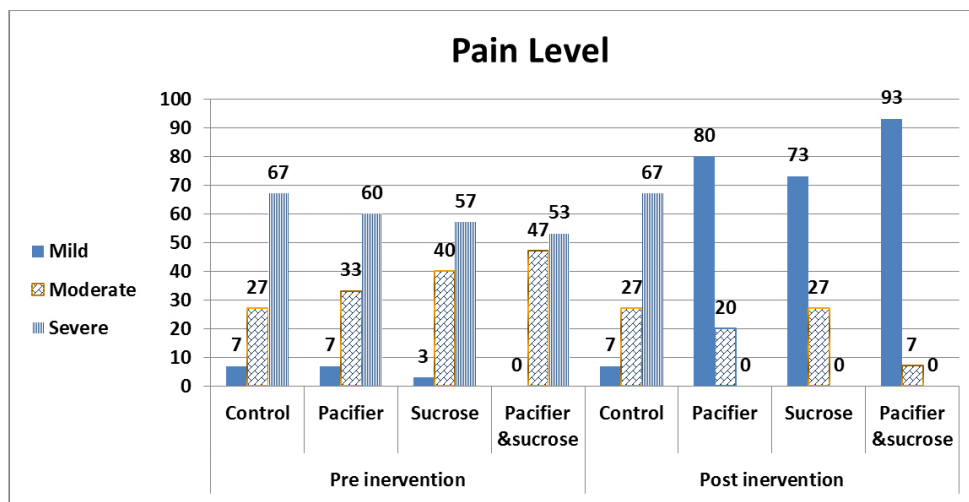


Figure 1. The mean pain scores of the different study groups pre and post-intervention

Table 3. Comparison among study groups regarding the mean pain scores

Group	Pain score Mean ± SD	p value	P1	P2	P3	P4	P5	P6
Pre-Intervention								
Control	14.1 ± 3.6							
Pacifier	13.93 ± 3.62	.997	.855	.855	.855	1.000	1.000	1.000
Sucrose	13.93 ± 3.5							
Pacifier & sucrose	13.93 ± 3.36							
Post-Intervention								
Control	14.1 ± 3.6							
Pacifier	6.57 ± 2.6	< .001*	< .001*	< .001*	< .001*	.123	.083	.001*
Sucrose	7.63 ± 1.99							
Pacifier & sucrose	5.37 ± 2.13							

Note. Anova test * Significant difference at p value < .01; p value: Comparison among all groups; P1: Comparison between control & pacifier P2: Comparison between control & sucrose; P3: Comparison between control & pacifier with sucrose; P4: Comparison between pacifier & sucrose; P5: Comparison between pacifier & pacifier with sucrose; P6: Comparison between sucrose & pacifier with sucrose.

4. DISCUSSION

It is estimated that, in the NICU, the neonates are subjected to 26 painful procedures out of 31 procedures used in the unit, only one third of them receive analgesic or behavioural therapy.^[4] In order to improve clinical practice and promotes better neonatal health, pain relieving methods are essential. OS and NNS have been widely evaluated and proved to have calming and pain relieving effects in neonates. There is an increasing evidence that, the synergistic effect of sucrose and NNS is superior to the effect of each of them alone.^[15]

This study was designed to clarify the efficacy of OS and pacifier either alone or in combination in the relief of procedural

pain among preterm neonates. This study was conducted in South Egypt where no previous similar studies were designed. In addition, the application of these simple and cheap methods to relieve procedural pain among neonates is suitable to our locality where the economic level is low. The study showed that, the application of the OS and/or pacifier, led to significant improvement of the levels of pain and reduction of the mean score of pain among preterm neonates during painful procedures. In addition, combined pacifier and OS was superior to OS alone and comparable to pacifier alone regarding their effect on the reduction of pain level and mean score of pain. These results are supported by several studies. Gibbins et al. (2002) showed that, the combination of OS

and NNS has superior analgesic effect than each of them alone among neonates undergoing painful procedures.^[16] Leef (2006) conducted a review including information on 1,077 infants enrolled in 16 studies and showed the safety and efficacy of OS in decreasing term infants' pain response to a single procedure.^[17]

Both OS and pacifiers effectively reduced pain scores during painful procedures among neonates.^[18] Boyle et al. (2006) evaluated OS and NNS for reducing pain responses during eye examination among preterm neonates and concluded that, NNS had lower pain scores than those with sucrose and no synergistic effect of sucrose and pacifier was found.^[19] Elserafy et al. (2009), in a study involving 36 ICU preterm newborns, concluded that, the use of combined OS and NNS was more effective than OS or NNS alone in the relieve of procedure related pain and added that, a synergistic effect between is suggested.^[8] Similarly, were the results of Naughton (2013) including full term and preterm newborns.^[15]

Polit and Beck (2014), revealed that, neonates receiving OS had significantly lower PIPP scores when compared with neonates in EMLA group (local anaesthetic agent). However, this study used term neonates, ≥ 36 weeks gestation. Therefore their findings could only be generalized in terms of its application to the healthy term neonates.^[20] Similar to our results, Hatfield et al. (2011) concluded that, going through the published randomized controlled trials implies that, OS given to neonates before painful procedures showed to be an effective, safe, convenient, and immediate-acting analgesic for reducing crying time and significantly decreased biobehavioral pain response.^[21] The role of OS for relief of procedure related pain was evaluated among 3,496 term and preterm neonates and it was concluded that, OS is effective and safe method and the authors recommended that, repeated doses of OS should be used.^[22] However, we used single OS dose with acceptable effect. Although studies reported that, combined pacifier and OS lowered O₂ saturation fluctuations and heart rate in comparison to OS alone,^[23] a meta-analysis showed that, combined OS and pacifier did not differ signifi-

cantly in lowering the risk of bradycardia, tachycardia, and O₂ desaturations incidence between the 2 groups^[24] which is not the case in the current study.

OS and/or NNS are effective in providing analgesia in full-term neonates undergoing heel-stick procedures, with the combined intervention being more effective compared with any single intervention.^[25] Liu et al. (2017) conducted a meta-analysis to evaluate the effect of combined OS and NNS for pain relief among newborns in NICU during painful procedures. They concluded that, the combination is effective not only for management but also for better prevention of procedure related pain among NICU newborns.^[24] The combination of NNS with OS provided better pain relief during repeated painful procedures than each of them alone. The effect of NNS was similar to that of OS on repeated procedural pain.^[26] It was showed that, neonates received better pain relief from 0.5 ml than 0.2 ml sucrose during venipuncture which support our results as we used the same dose.^[27]

5. CONCLUSION

In conclusion, OS and pacifier are effective as pain reliever during painful procedures among preterm neonates. In addition, the effect of combined OS and pacifier as pain reliever is superior to OS and pacifier alone. The use of these simple, cheap, available, safe and effective methods as procedural pain relievers among neonates should be recommended and applied in all NICU to be a routine work. All nurses dealing with neonates should be oriented by the significance of these simple methods using various means of demonstration. The next step will be the assessment of these methods as pain reliever before different invasive procedures among older infants in comparison to pharmacological methods which are usually expensive and associated with side effects.

CONFLICTS OF INTEREST DISCLOSURE

The authors declare that there is no conflict of interest statement.

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