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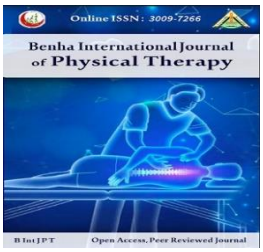

Original research

Reflex Rolling versus Lung Squeezing Techniques on Pulmonary Functions in Premature Neonate With Pneumonia.

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Abstract

Background: Respiratory complications are a major contributor to neonatal morbidity and mortality, particularly in developing countries. These issues are predominantly observed in premature neonates and frequently include conditions such as respiratory distress syndrome (RDS) and pneumonia, often necessitating ventilatory support or supplemental oxygen. **Purpose:** To compare the effect of reflex rolling and lung squeezing techniques on pulmonary functions in premature neonates with pneumonia. **Methods:** Neonates were randomly assigned into two equal groups from both sexes with 12 neonates in each group. (Group A and B), both groups received a specific physical therapy program for 15 min., while Group (A) received a reflex rolling technique and Group (B) received a lung squeezing technique. For two successive weeks, the intervention program was implemented for 20 min, two sessions/day, five times a week for both groups. The severity of respiratory distress was measured using the Silverman-Andersen Scale, Respiratory Rate was measured using a monitor (Hunt Leigh Healthcare /United Kingdom) at baseline and after two weeks of intervention for both groups and the period of hospitalization was determined by subtracting the date of starting physical therapy program from the date of discharge. **Results:** At the beginning of the intervention, there were no statistically significant differences between the two study groups ($P > 0.05$). However, following two weeks of intervention, both groups exhibited significant improvement in all the variables including; the severity of respiratory distress and the respiratory rate at discharge as compared to the measured admission values. Furthermore, the Lung Squeezing group had a noticeably decreased period of hospitalization ($P < 0.05$) compared to the Reflex Rolling group. **Conclusion:** The present study concludes that reflex rolling and lung squeezing are effective methods in improving all outcome measures in preterm neonates with pneumonia with favoring for the lung squeezing method in reducing the period of hospitalization, and both techniques can be applied safely in clinical settings.

Keywords: Pneumonia, Reflex rolling, Lung squeezing.

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INTRODUCTION

Neonatal pneumonia occurs in 0.5–1.0% of full-term infants and 10–15% of those born prematurely. This condition often results from maternal immunity factors that impair neonatal immune system function, particularly affecting innate immunity mechanisms [1].

Key clinical indicators for diagnosing pneumonia in neonates include fever, rapid breathing (tachypnea), nasal flaring, cough, breathlessness, chest wall retractions, and low oxygen saturation levels [2].

Chest physical therapy (CPT) is widely recognized as a supplementary intervention for managing pneumonia, especially in neonatal intensive care units (NICUs). The primary goal of CPT is to enhance airway clearance by aiding the removal of inflammatory fluids, tracheobronchial secretions, and obstructions, thereby reducing airway resistance. This process is essential for improving respiratory function and gas exchange, particularly in neonates with respiratory diseases [3].

In NICUs, CPT is a fundamental component of airway management for newborns. Its objectives include clearing bronchial secretions, improving oxygenation, and optimizing lung performance. Techniques such as vibration, percussion, and postural drainage are commonly employed to facilitate secretion clearance. These methods are based on the principle that effective airway clearance is vital for achieving optimal respiratory outcomes, particularly in neonates requiring substantial breathing assistance [4].

Recent advancements in CPT techniques include the lung squeeze technique (LST) and reflex rolling. LST involves applying manual compression to the chest wall across the hemithorax, while reflex rolling, based on Vojta's methodology, uses tactile stimulation and isometric strengthening to promote normal movement patterns and improve breathing efficiency [5].

METHODS

This research was authorized by Delta University for Science and Technology, Faculty of Physical Therapy Ethical Committee for Clinical Research (FP.T2407026), and it was also registered on ClinicalTrials.gov and has the NCT06706128 identification number. And done from June 2024 to November 2024. All neonates who participated were recruited from the governmental hospitals of Dakahliya. Before starting the study procedures, each neonate's parents signed an informed consent form to ensure their satisfaction and informed them that they have the right to withdraw from the study without any penalty by keeping their data confidential. The study of technique and objectives were well understood by Parents and adhered to ethical guidelines. Neonates were classified as either included or excluded based on the following criteria: they were included if they were premature neonates with pneumonia of both sexes with 30-37 weeks of gestation and admitted to NICU, free from any congenital malformation, and clinically and thermodynamically stable.

Preterm neonates were excluded because of the following: under Treatment with neurotropic drugs, their temperature is >38, have any respiratory and cardiac congenital anomalies or genetic disorders, suffering from interventricular hemorrhage or seizures, underwent any surgical procedures, any segmental or lobar collapse confirmed on chest x-ray, having airway interventions including change of endotracheal tube, hand ventilation or bronchial lavage.

Sample Size Calculation:

Using g-power software program (version 3.1.9.4) and based on the previous study of Shanmugananth et al**.** [6], it was estimated that a sample size of 20 patient would achieve a power of 80% with assuming a type I error (p= 0.05) to detect an effect size of (1.3249474) in the outcome measures of interest. If we anticipate a 20%

dropout rate, we would need to recruit approximately 24 patients (twelve in each group). The selected subjects divided randomly into two groups of equal numbers **(group A and group B)**, 12 neonates in each group.

Randomization:

In this research, forty preterm neonates were recognized as possible participants; however, five were excluded for not meeting the inclusion criteria and four parents opted out of participation. One participant passed away, and two others were moved to a different NICU. Consequently, twenty-four preterm neonates with pneumonia were included in the study. They were randomly assigned into two equal groups, with fourteen individuals in each. In the reflex rolling group, two children discontinued the treatment program before the final assessment, while in the lung squeezing group, two preterm neonates left due to being transferred to another NICU. As a result, twelve preterm neonates from each group completed the study **(Figure 1).**

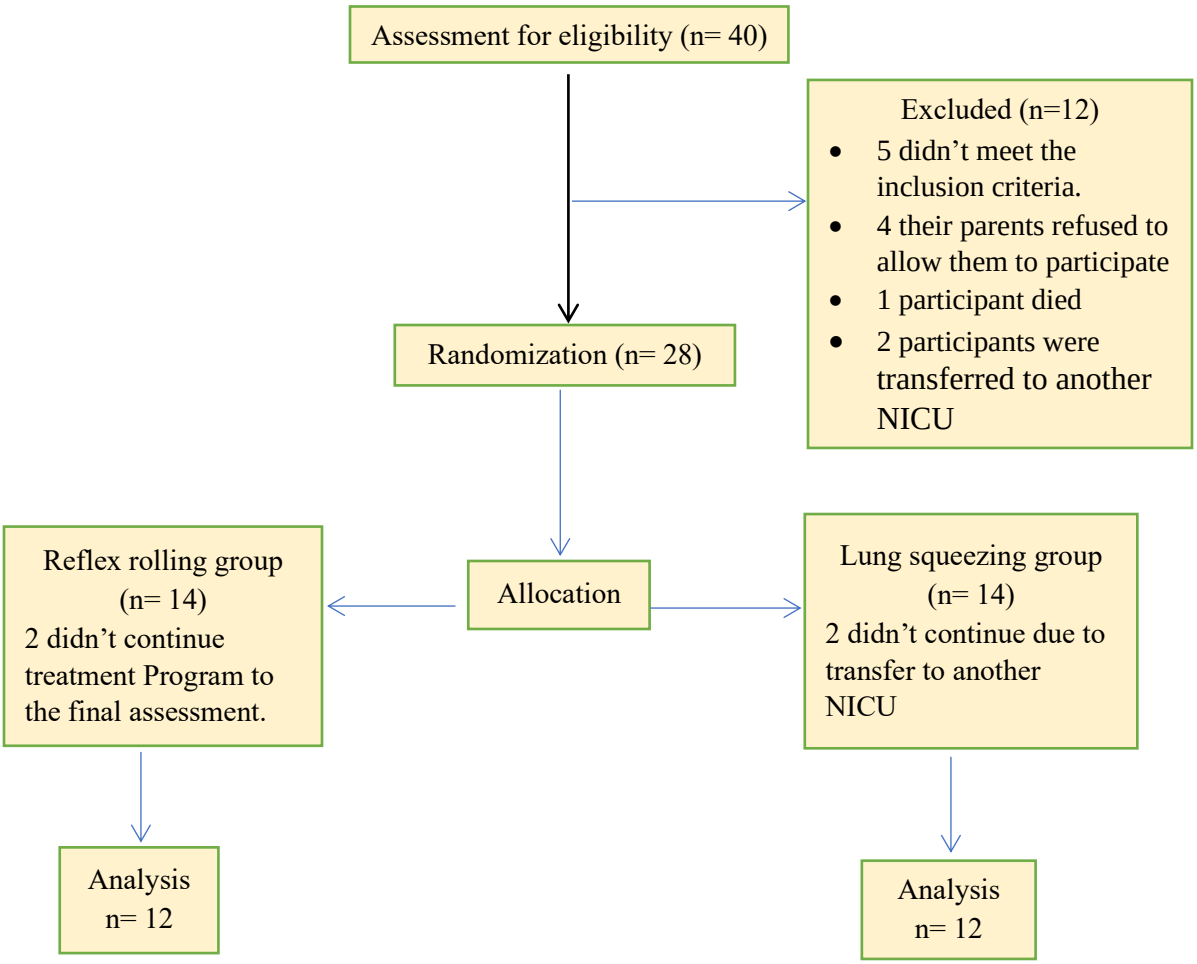

Fig (1) Study Flow Chart

A total of twenty-four neonates diagnosed with pneumonia were randomly divided into two equal groups, each consisting of twelve neonates. Group A underwent reflex rolling, while Group B engaged in lung squeezing. The process of randomization was conducted using sealed envelopes to decide the group each neonate would belong to. The neonates in both groups participated in the same designated

physical therapy program for 15 minutes. Additionally, group A experienced the reflex rolling method for 20 minutes, whereas group B utilized the lung squeezing method for 20 minutes. All participants received their respective treatments for two sessions each day, five days a week, over the course of two weeks.

Assessment Procedures:

Assessment was conducted before and after the rehabilitation program's completion for all groups as detailed below:

• The intensity of Respiratory Distress was evaluated using the Silverman-Andersen scale, which involves observing upper chest movement, intercostal retraction, xiphoid retractions, nasal flaring, and expiratory grunting, rated on a scale of 0, 1, or 2.

• The Respiratory Rate was measured with monitors (Hunt Leigh Healthcare / United Kingdom).

• The length of hospitalization was determined using the following formula:

Length of Hospitalization = Date of Discharge - Date when physical therapy commenced.

Treatment Procedures:

Specific Physical Therapy Program

Preterm neonates in both groups participated in a designated physical therapy program lasting 15 minutes, which consisted of 5 minutes dedicated to each of the following: postural drainage, percussion, and vibration.

Reflex Rolling Technique

The neonate was positioned asymmetrically on their back, with the head gently turned toward the side from which the stimulus was applied. Gentle pressure was exerted with the fingers on the chest area, directed in a dorsal-medial and cranial manner, moving diagonally toward the spine, focusing on the chest around the 6th rib or between the 5th and 6th ribs, or between the 6th and 7th ribs.

Lung Squeezing Technique

The neonate remained in a supine position while the therapist placed one hand on the posterolateral aspect of the hemithorax and the other hand covered the anterior chest, extending from the lower ribs to above the clavicle. Three to four gentle compressions were performed on the hemithorax, each lasting approximately five seconds. After every set, a slow, gentle release phase was allowed to ensure full relaxation of the chest wall before the next set. Compressions were applied to one hemithorax for 5 minutes before the therapist switched to the opposite hemithorax and repeated the process for another 5 minutes. Vibration was incorporated into the technique, which was not performed in a gravity-assisted position [7].

Statistical analysis:

The data were examined to assess normality and homogeneity of variance. The Shapiro-Wilk test was utilized for the normality assessment, and after eliminating outliers identified through box and whiskers plots, the data exhibited a normal distribution ($P>0.05$). Furthermore, Levene's test for homogeneity of variance indicated no significant difference ($P>0.05$). Therefore, the data is normally distributed, allowing for parametric analysis to be performed.

The statistical analysis was carried out using SPSS software version 25 for Windows (SPSS, Inc., Chicago, IL). Quantitative variables, such as age, respiratory distress severity, respiratory rate, and hospitalization duration, are presented as mean and standard deviation. Qualitative variables, including gender, are reported as frequency (percentage). An independent t-test was employed to compare patient age between two groups. The chi-square test was applied to compare gender variables within and between groups. A mixed design 2 x 2 Multivariate Analysis of Variance (MANOVA) test was conducted, where the

first independent variable (between subjects' factor) was the tested group with two levels (reflex rolling group vs. lung squeezing group) and the second independent variable (within subjects' factor) comprised measuring periods with two levels (pre-treatment vs. post-treatment). The main dependent variables included the primary outcomes (severity of respiratory distress, respiratory rate, and hospitalization duration). The Bonferroni correction test was utilized for pairwise comparisons within and between groups for the tested variables which showed significant F values from the MANOVA test. All statistical analyses were considered significant at a probability level of ($P \leq 0.05$).

RESULTS

In this study, a total of 24 premature neonate patients diagnosed with pneumonia, comprising 13 males and 11 females, were involved and randomly divided into two equal groups of 12 patients each.

The demographic data presented in Table 1 indicated that there were no statistically significant differences (P>0.05) between the reflex rolling group and the lung squeezing group concerning the mean age of pneumonia patients (P=0.166) and gender distribution (P=0.219).

Table 1. Demographic data for premature neonate patients with pneumonia in both groups

Items	Groups (Mean ±SD)		*P*-value
	Reflex rolling group (n=12)	Lung squeezing group (n=12)	
Age (year)	34.17 ±1.03	34.75 ±0.96	0.166
Gender	8 (66.70%): 4 (33.30%)	5 (41.70%): 7 (58.30%)	0.219

Quantitative variable data (age) are expressed as mean ±standard deviation (SD) and compared statistically by independent t-test. Qualitative variable data (gender) are expressed as frequency (percentage) and compared statistically by Chi-square test.
P-value: probability value P-value>0.05: non-significant

The results of the statistical multiple pairwise comparison tests for respiratory distress severity, respiratory rate, and length of hospitalization in each group are summarized in **Table (2)**. A notable (P<0.05) reduction in the severity of respiratory distress (refer to **Table 2 and Figure 1**) was observed at post-treatment versus pre-treatment in both the reflex rolling group (P=0.0001) and lung squeezing group (P=0.0001). The percentage change and improvement in respiratory distress severity due to the effects of time in the reflex rolling group were 5.25 and 100%, respectively, while in the lung squeezing group the values were 5.00 and 100%, respectively. Additionally, a significant (P<0.05) reduction in respiratory rate (see **Table 2 and Figure 2**) was noted at post-treatment compared to pre-treatment for the reflex rolling group (P=0.0001) and the lung squeezing group (P=0.0001). The percentage change and improvement in respiratory rate due to the time effect in the reflex rolling group were 17.17 and 26.97%, respectively, while in the lung squeezing group these figures were 16.07 and 25.03%, respectively. The length of hospitalization (refer to **Table 2 and Figure 3**) showed a significant increase (P<0.05) at post-treatment compared to pre-treatment for both the reflex rolling group (P=0.0001) and the lung squeezing group (P=0.0001), with changes of 11.58 and 9.00, respectively.

The statistical multiple pairwise comparison tests assessing the severity of respiratory distress, respiratory rate, and duration of hospitalization between the two groups are detailed in **Table (2)** and **Figures (1-3).** At the pre-treatment stage, there were no statistically significant differences (P>0.05) between the reflex rolling group and the lung squeezing group regarding respiratory distress severity (P=0.164), respiratory rate (P=0.788), and length of hospitalization (P=1.000). At the post-treatment stage, there were also no significant statistical differences (P>0.05) between the reflex rolling group and lung squeezing group in terms of severity of

respiratory distress (P=1.000) and respiratory rate (P=0.444). However, a significant difference was found between the reflex rolling group and lung squeezing group (P<0.05) regarding the mean values of the hospitalization period post-treatment (P=0.025).

Table 2: Within and between group comparisons for main outcome variables

Variables	Items	Groups (Mean ±SD)		Change	95% CI	P-value[2]
		Reflex rolling (n=12)	Lung squeezing (n=12)			
Severity of respiratory distress	Pre-treatment	5.25 ±0.45	5.00 ±0.73	0.25	-0.10 – 0.60	0.164
	Post-treatment	0.00 ±0.00	0.00 ±0.00	1.00	-0.35 – 0.35	1.000
	MD (Change)	5.25	5.00			
	95% CI	4.89 – 5.60	4.64 – 5.35			
	Improvement %	100.00%	100.00%			
	P-value[1]	0.0001*	0.0001*			
Respiratory rate	Pre-treatment	63.67 ±4.69	64.25 ±6.60	0.58	-3.76 – 4.93	0.788
	Post-treatment	46.50 ±1.38	48.17 ±6.64	1.67	-2.68 – 6.01	0.444
	MD (Change)	17.17	16.08			
	95% CI	12.81 –21.51	11.73 –20.43			
	Improvement %	26.97%	25.03%			
	P-value[1]	0.0001*	0.0001*			
Hospitalization period	Pre-treatment	1.00 ±0.00	1.00 ±0.00	0.00	-0.2.24 – 2.24	1.000
	Post-treatment	11.58 ±4.83	9.00 ±2.52	2.58	0.34 – 4.82	0.021*
	MD (Change)	10.58	8.00			
	95% CI	8.34 – 12.82	5.75 – 10.24			
	P-value[1]	0.0001*	0.0001*			

Data are expressed as mean ±standard deviation and compared statistically by MANOVA test
MD: Mean difference CI: confidence interval P-value: probability value * Significant (P<0.05)
P-value[1]: Probability value within each group; P-value[2]: Probability value within among groups

DISCUSSION

This research aimed to assess the impact of reflex rolling and lung squeezing techniques on pulmonary function in premature infants with pneumonia, ranging from 30 to 37 weeks of gestation, who were admitted to the NICU and were free from congenital anomalies, while remaining clinically and thermodynamically stable.

The findings indicated significant enhancements in the post-treatment average values for respiratory distress severity, respiratory rate, and length of hospitalization, as compared to the pre-treatment average values (P<0.05) in both groups of preterm neonates, although a decrease in hospitalization duration was more pronounced in the lung squeezing group.

The study's results demonstrated that the reflex rolling technique achieved a 100% improvement in respiratory distress severity, a 26.97% reduction in respiratory rate, and lessened hospitalization duration.

The enhancement of respiratory function resulting from reflex rolling therapy can be ascribed to the stimulation of the central nervous system through applying pressure to specific body areas, which leads to better respiratory mechanics by expanding the rib cage, improving diaphragmatic function, and fostering deeper, more coordinated breathing. This method also helps coordinate swallowing, sucking, and breathing, which

alleviates respiratory effort and reduces the risk of aspiration. It encourages airway openness and effective breathing patterns by promoting vegetative and postural stability.

Kaundal et al., [8] conducted a study to evaluate the efficacy of chest physiotherapy with reflex rolling in preterm infants suffering from respiratory distress syndrome and found that it was more effective than chest physiotherapy alone in enhancing respiratory distress severity and respiratory rate.

The findings of this study corroborate those of El-Shaarawy et al., [9] who indicated that the reflex rolling technique is both safe and effective in reducing the length of hospital stays for premature neonates facing respiratory distress syndrome.

The study's outcomes showed that the lung squeezing technique achieved a 100% improvement in respiratory distress severity, a 25.03% reduction in respiratory rate, and decreased hospitalization time.

The enhancement in respiratory function following lung squeezing therapy can be explained by an increase in mean respiratory system compliance (Crs), which results from a greater number of alveoli being actively engaged in ventilation and gas exchange. Consequently, pulmonary resistance diminishes, and overall respiratory efficiency improves, allowing for a quicker return to normal lung function.

Aherrao et al., [10] conducted research on the effects of the thoracic squeezing technique on neonates experiencing neonatal respiratory distress syndrome and concluded that lung squeezing technique (LST) improves respiratory health, alleviates respiratory distress, reduces the severity of respiratory issues, leads to shorter hospital stays, and enhances neurodevelopmental outcomes.

Our study's results align with those of Ashary et al., [11] who reported that combining LST with chest physiotherapy resulted in more significant improvements in dynamic lung compliance, heart rate, and respiratory rate in children with respiratory issues.

Moreover, we observed that the average number of intervention days was 11.58 ± 4.83 days for the reflex rolling group and 9.00 ± 2.52 days for the lung squeezing group. This variation is due to the additional benefits of LST administered to the preterm neonates in the lung squeezing group, which suggests that fewer intervention days were necessary for this group. Therefore, neonates in this category displayed quicker improvements.

Strengths and limitations of the study:

The results of this study offered essential information into the impact of reflex rolling and lung squeezing on managing respiratory problems in preterm infants suffering from pneumonia.

This research does have some constraints. To begin with, there was no long-term follow-up conducted. Moreover, the findings may not be applicable to neonates of varying gestational ages, different severities of pneumonia, or those with other health concerns. Lastly, the absence of a control group in this research is notable, as the participants belong to a vulnerable population, and subjecting them to a placebo might significantly endanger their health.

CONCLUSION

The present study concludes that reflex rolling and lung squeezing are effective methods in improving all outcome measures in preterm neonates with pneumonia with favoring for the lung squeezing method in reducing the period of hospitalization, and both techniques can be applied safely in clinical settings.

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Data Availability Statement: Data is available from the corresponding author upon reasonable request.

Conflicts of Interest: None.

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