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Effect of lung squeezing technique for correcting atelectasis in mechanically ventilated preterm infants with respiratory distress syndrome

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ABSTRACT

Background

Respiratory distress syndrome (RDS) is the primary cause of neonatal mortality¹ usually occurring in infants of less than 35 weeks of gestation.² In the surfactant deficient lung of preterm infants with respiratory distress, an unstable state occurs between alveoli, leading to diffuse atelectasis.³ Various manual techniques like conventional chest physiotherapy (CCP) and lung squeezing technique (LST) are used in neonatal settings to mobilize secretions, enhance mucociliary clearance and reexpanding the atelectatic regions of the lung.^{9,10} However the available evidences of comparing the effectiveness of both techniques are very few.

Objective: To test the efficacy of Lung Squeezing Technique with that of Conventional Chest Physiotherapy for correcting atelectasis in mechanically ventilated pre term infants with RDS.

Study design: Experimental study

Method: With parental consent, 30 infants with gestational ages of less than 37 weeks who required mechanical ventilation and with presence of a segmental or lobar collapse confirmed on a chest X-ray, were randomly enrolled into this study. Fifteen infants in LST and CCP each. Chest radiograph was taken three days after intervention as outcome measure.

Result: After three days of intervention program Lung squeezing technique showed statistically higher improvement compared with the conventional chest physiotherapy.

Conclusion: LST is more effective in correcting atelectasis as compared to CCP technique in mechanically ventilated preterm infants with RDS. LST is less stressful and practically convenient technique than CCP technique.

Keywords: Respiratory Distress Syndrome, Lung Squeezing Technique, Conventional Chest Physiotherapy

INTRODUCTION

Respiratory distress syndrome (RDS) is the primary cause of neonatal mortality¹ usually occurring in infants of less than 35 weeks of gestation.² In the

surfactant deficient lung of preterm infants with respiratory distress, an unstable state occurs between alveoli, leading to diffuse atelectasis³. Evor Wong described that in preterm infants with uneven

ventilation, hyperinflated lung units may compress adjacent lung units and pre dispose them to atelectasis.⁴

Neonates have proportionately larger airways relative to their lung volume at functional residual capacity.^{5,6} This advanced development of small airways is essential to provide conduit for alveolar expansion and ventilation in newborns, especially with paucity of collateral alveolar connections.⁷

Due to their immature respiratory system, premature newborn infants are particularly at risk of developing respiratory complications with the need for mechanical pulmonary ventilation, and thus chest physical therapy techniques have become an increasing part of the management of newborns in Neonatal Intensive Care Units (ICU).⁸ Various manual techniques are used in neonatal settings to mobilize secretions, enhance mucociliary clearance and reexpanding the atelectatic regions of the lung.^{9,10} In the neonatal population, CPT is used to prevent and treat lung collapse and consolidation^{11,12,13} and have shown positive effects including improved oxygenation^{14,15} and increased removal of secretions¹⁶. However, the use of CPT has also received much criticism, largely as a result of reports of adverse outcomes. Documented adverse outcomes include hypoxaemia¹⁷, bruising, rib fractures¹⁸, and intracranial lesions such as intraventricular haemorrhage¹⁹ and porencephalic cysts^{20,21}. The lung Squeezing Technique (LST) is a form of manual technique in which chest wall compression is performed on the whole hemithorax.⁴ Silva et al, in their study concluded that LST can be safely applied in very low birth weight, stable premature infants in the post-extubation period.⁹ According to my knowledge, the available evidences of comparing this two techniques are very few.

AIM AND OBJECTIVE

To test the efficacy of Lung Squeezing Technique with that of Conventional Chest Physiotherapy for correcting atelectasis in mechanically ventilated pre term infants with RDS.

MATERIAL AND METHODOLOGY

With parental consent, 30 infants with gestational ages of less than 37 weeks who required mechanical ventilation and with presence of a segmental or lobar

collapse confirmed on a chest X-ray, were randomly enrolled into this study. Fifteen infants in LST and CCP each infants with persistent pulmonary hypertension, meconium aspiration syndrome, congenital heart defects, pneumonia presenting with generalized patchy consolidation, post cardiothoracic surgery, plural effusion, and pneumothorax were excluded. The infants were evaluated for lung auscultation, respiratory pattern, pulse oximetry, radiological pattern, ventilatory parameters and ABG analysis. Chest radiography was taken as the outcome measure.

According to our neonatal intensive care unit (NICU) protocol, chest radiography was performed at least every third day on all mechanically ventilated infants and subsequently whenever clinically indicated, as determined by attending neonatologist who was blinded to the study. The interpretation of atelectasis was based on a combination of signs including volume loss, fissure line displacement and pattern of opacification. Full expansion of atelectasis was defined as the absence of opacification, and homogenous distribution of ventilation in the affected lobe when compared to other lung regions.

TREATMENT PROTOCOL

Therapy sessions were performed twice daily at specified times. Both "Group A" and "Group B" received Medical treatment & Pharmacotherapy treatment as prescribed by the neonatologist. Vital signs monitoring was carried out before, during and after intervention. Respective medical staff was called if any signs of distress was observed.

CONVENTIONAL CHEST PHYSIOTHERAPY (GROUP B)

Percussion and vibration in the modified postural drainage positions were performed with the infant lying alternately on his/her two sides, without head elevation, for 10 minutes, followed by endotracheal suctioning. Percussions were given with tented fingers and vibration performed manually by using the fingers to cause a fine shaking motion of the chest wall.⁴

DATA ANALYSIS

Unpaired t tests were used to find out homogeneity of two groups for all the parameters at baseline and to

compare the outcome measurement data between two groups. Chi-square test was carried out to determine from X-ray whether atelectasis improved significantly before and after the intervention

between two groups. Each calculated t-value was compared with t-table value to test one tailed hypothesis at 0.005 level of significance.

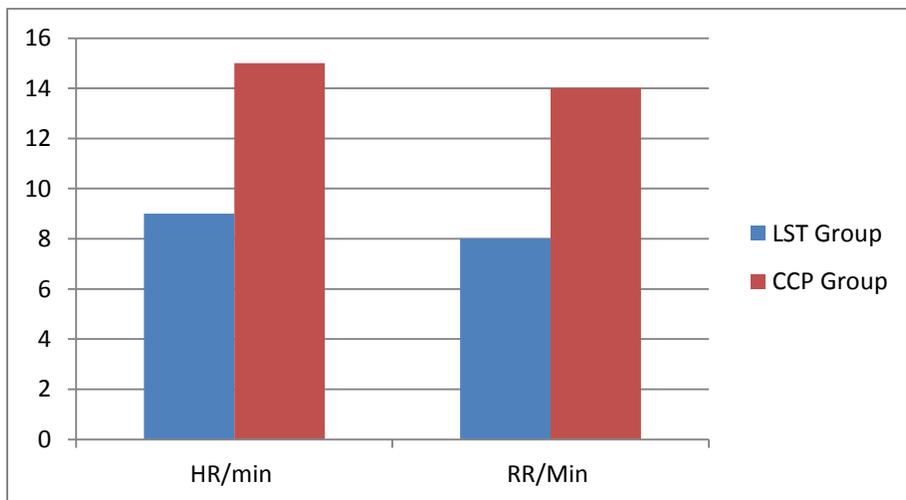
Table -1 Demographic data of neonates and ventilatory parameters showed homogeneity between two groups.

	LST GROUP (n = 15)	CCP GROUP (n = 15)
Gestational age (weeks) Mean ± SD	29.7 ± 2.3	29.9 ± 2.7
Birth weight (gram) Mean ± SD	1.242 ± 472	1.236 ± 469
Male gender	(10/15)	(12/15)
FiO2	0.26 ± 0.05	0.24 ± 0.05
Peak inspiratory pressure (cmH2O)	14.8 ± 4.5	15 ± 4.2

After three days of intervention program, both the groups showed significant improvement in atelectasis compared with pre intervention measurement. Using a chi-square test on the data, ($\chi^2 = 2.98$, $df = 1$), the result were found to be significant at $p < 0.05$ for a

one tailed test. However the Lung squeezing technique Group showed statistically higher improvement in outcome measure compared with the Conventional chest physiotherapy group after intervention.

Graph: comparison of physiological variables during therapy between two groups:



The study also showed that heart rate and respiratory rate were significantly higher during CCP technique intervention as compared to LST group.

DISCUSSION

Distribution of lung atelectasis among various lobes were similar between the two groups ($df = 5, p = 0.853$); right upper lobe collapse constituted the majority of lobar collapse in both the groups (66% in LST group and 75% in CCP group). After three days of intervention program, both the groups showed significant improvement in atelectasis compared with pre intervention measurement. EvorWong suggested that chest wall compression by either percussion or LST would decompresses the hyper inflated lung units and might facilitates the resolution of atelectasis.⁴ However the LST Group showed statistically significant, higher improvement in outcome measure compared to CCP group after intervention. Similar result was reported by Wong 2003 who found that the lung squeezing technique (LST) resulted in a decrease in the number of infants with non-resolution of atelectasis after the first treatment; This study also reported that LST took significantly fewer therapy sessions to attain full re-expansion of the atelectatic lung than the CCP group ($p < 0.001$). The difference in the outcome measures between the two interventions may be due to emptying of lung units with low time constants with brief and forced oscillation of percussion. Contrarily, LST decompresses the slowly emptying, hyper inflated lung units, which facilitates lung re expansion.²³ Zidulka A and King M et al concluded that in LST, this decompression effect might be due to cephalad bias in airflow and greater peak expiratory airflow when compared to inspiratory airflow and was demonstrated to promote re expansion of atelectatic lung regions.^{24, 25} Increase in respiratory system compliance with LST may occur as a result of re – expansion of the collapsed peripheral airways, and continuous process of recruitment of atelectaticacini.²⁶The increase in compliance following LST in the neonates may occur as a result of the recruitment of atelectatic lung units and a more homogeneous distribution of ventilation within the lung units.²⁷

Brandford BF did study in children receiving mechanical ventilation after cardiac surgery, which suggested that lung compression from percussion may cause decrease in functional residual capacity.²⁸Also technically, vibration is usually done during the expiratory phase of breathing and because the

infant with respiratory distress often has a rate of 40 or more breaths per minute, it is difficult to coordinate manual vibration with the expiratory phase of breathing.²⁹ This study also showed that heart rate and respiratory rate were significantly higher during CCP technique intervention as compared to LST group similar to David dyer and Bashir khan et al who found that percussion was frequently associated with an increase in heart rate and de saturation.¹⁰

Evorwong 2006, in his study also concluded that Respiratory system resistance (Rrs) showed no significant change after LST. There are two possible explanations for why this concomitant decrease in respiratory system resistance did not occur despite an increase in compliance. Firstly the recruitment process only takes part in lung units without involvement of any correction of airway closure and, therefore, resistance does not change. Due to the paucity of collateral ventilation in neonates, most of the recruitment process has to take place through the route of peripheral airways Secondly, the reduction of peripheral airway closure does occur but the changes are too small to be detected. Airways less than 2 mm only account for about 10 - 25 % of the total Rrs. Therefore, it is not surprising that Rrs change due to recruitment of collapsed peripheral airways was not detected.³⁰ But LST improves respiratory system compliance in preterm infants with respiratory distress syndrome who require mechanical ventilation So LS T maybe used as an intervention to enhance even distribution of ventilation in mechanically - ventilated infants with respiratory distress syndrome³⁰

FURTHER SCOPE OF STUDY

- Other clinically important outcomes which should be assessed include,
 - Duration of oxygen therapy,
- Length of hospital stay.
- Other ventilatory parameters
 - Arterial blood gas analysis.
 - study should be carried out in other neonatal lung diseases.

CONCLUSION

This study concluded that LST is more effective in correcting atelectasis as compared to CCP technique

in mechanically ventilated preterm infants with RDS. Also LST is physiologically less stressful and practically more convenient technique than CCP technique.

LIMITATION OF STUDY

- The sample size is small.
- The outcome measures were taken only once after three days program, hence long term maintenance of lung expansion was not checked.

- Daily X-ray was not taken to see immediate effect of either technique.

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