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Case Report

Paediatrics Section

Chest Physiotherapy as an Adjunct in a Mechanically Ventilated Infant with Atelectasis: A Case Report

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ABSTRACT

Atelectasis occurs due to impaired airway clearance or complete airway obstruction caused by inflammation, leading to the collapse of tiny airways either partially or completely. This results in impaired exchange of carbon dioxide and oxygen. A chest X-ray, Computed Tomography (CT), and/or thoracic ultrasound are helpful in identifying atelectasis. In the present case, a 5-month-old female infant was reported to the Paediatric Department with the chief complaint of seizure and loss of consciousness. An X-ray was performed, revealing complete left lung atelectasis with no air entry. The infant was referred for physiotherapy in addition to medical management. Through seven intensive and regular sessions of respiratory physiotherapy, which included techniques such as percussion, vibration, and postural drainage for more than 30 minutes, there was successful resolution of the consolidation and improvement in presenting symptoms. After the final sessions of physiotherapy, the infant was discharged with physiotherapy home programs. This suggests that physiotherapy is an integral part of paediatric critical care, ensuring a good prognosis and faster recovery.

Keywords: Airway collapse, Mechanical ventilators, Vibration technique

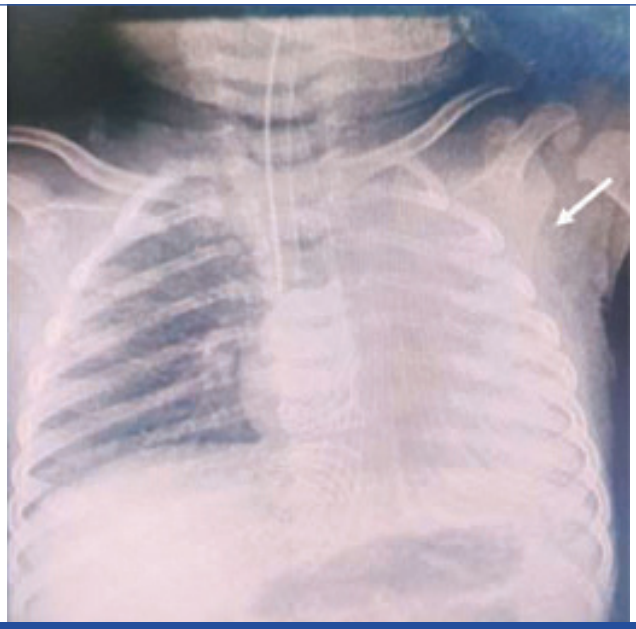
CASE REPORT

A 5.15-month-old female infant was referred to the Paediatric Department with complaints of seizure and loss of consciousness. The infant had been experiencing cold, rhinitis, shortness of breath, and reduced appetite for the past three days. In an attempt to alleviate the symptoms, home remedies including turmeric and pepper milk were given to the baby. However, since there was no improvement, medical advice was sought, and the baby was prescribed thiamine 0.5 mg/day and dexamethasone 0.3 mg/kg/day.

After three days of the onset of symptoms, the infant experienced the first episode of seizure and loss of consciousness, leading to their referral to a tertiary care hospital where this case report was documented. Upon arrival at the hospital, the infant was unresponsive and had a score of 5 on the paediatric Glasgow Coma Scale. They were directly admitted to the Paediatric Intensive Care Unit (PICU) due to an increased respiratory rate of 60 breaths/minute, an increased heart rate of 152 beats/minute, and a decreased SpO_2 rate of 85%. The baby required intubation and mechanical ventilation for respiratory support.

Initially, the infant was placed on Synchronised Intermittent Mandatory Ventilation (SIMV) mode with FiO_2 set at 100% and PEEP set at 5 cm H_2O. Despite the mechanical ventilation, the infant exhibited feeble attempts at spontaneous breathing that did not sufficiently meet the tidal volume and had to be compensated for by the mechanical ventilator through an endotracheal route. The infant continued to have an increased respiratory rate of 140 breaths/minute and an SpO_2 level of 86% despite the mechanical ventilation.

Upon observation, the infant exhibited symptoms indicative of increased work of breathing, such as nasal flaring, reduced chest expansion, abnormal breathing pattern, use of accessory muscles of respiration, and intercostal in-drawing. Coarse crepitation was heard over the upper segments of the left lung on auscultation, with absent breath sounds over the lingula and lower segments. A chest X-ray confirmed the diagnosis of complete left lung atelectasis, with minimal air entry in the upper lobe and complete consolidation of the lingula and lower lobes [Table/Fig-1].



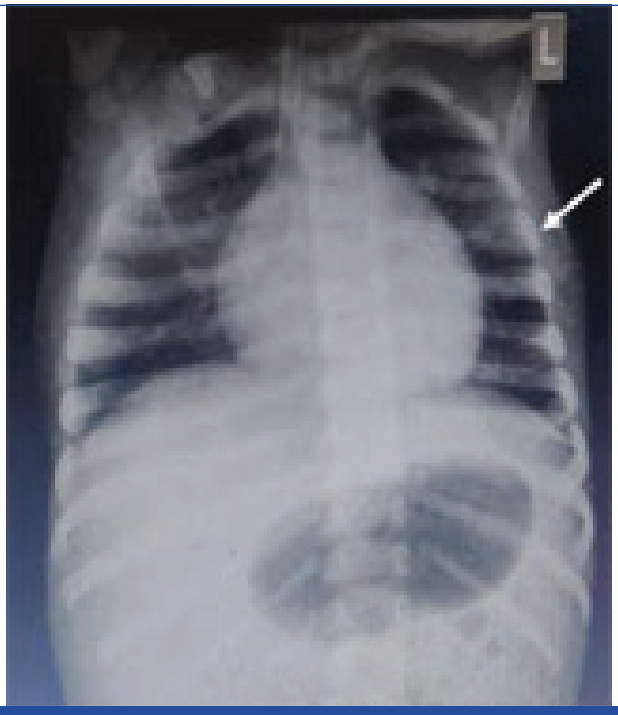
[Table/Fig-1]: The complete consolidation of the left lung before the physiotherapy session (arrow mark in this x-ray).

The infant received the following medications: injections of lignocaine 1 mg/kg (5 mg), fentanyl 1 mg/kg (5 mg), midazolam 5 mL, rocuronium 0.6 mg/kg (3 mg), propofol 1 mg/kg (5 mg), ceftriaxone 1 mg/kg (5 mg), and vitamin K 5 mg for two days, in addition to mechanical ventilation. After a thorough assessment, a physiotherapy treatment plan was developed. A total of seven physiotherapy sessions were conducted, with the goals of clearing the airways, enhancing lung expansion, improving ventilation-perfusion matching, and facilitating spontaneous breathing. Proprioceptive neuromuscular facilitation methods and airway clearance techniques, including percussion, vibration, suctioning, postural drainage, and positioning, were included in the physiotherapy treatment based on a review of the literature [Table/Fig-2,3] [1-4].

There was a significant improvement in the infant's condition, leading to independent breathing, and subsequently, the infant was discharged from the hospital after four days [Table/Fig-4]. During the follow-up visit after two weeks, the infant had no issues during assessment, and air entry and breath sounds were clear.

Symptoms	Goals	Physiotherapy intervention
Atelectasis and obstructed airways	To remove secretions, clear the airways and re-inflate the lungs.	Nebulisation and bronchial hygiene therapy • Percussion technique • Vibration technique • Postural drainage Oral and endotracheal Suctioning.
Reduced air entry over left lung and ventilation perfusion mismatch	To increase and maintain the air entry over left lung, to improve the ventilation perfusion ratio and increase oxygen saturation.	Positioning, segmental breathing and PNF technique to improve lung expansion.
Increase in respiratory rate and abnormal breathing pattern	To decrease respiratory rate and improve respiratory mechanics.	PNF to reduce work of breathing, accessory muscle inhibition, breathing retraining techniques.
Dependency on mechanical ventilation	To increase the number and quality of spontaneous breaths, to facilitate weaning and extubate the baby thereby encouraging regular breathing.	Adapt positions to facilitate spontaneous breaths at tidal volume, trigger the cough reflex to initiate active expectoration, weaning trial with variations in mode and FiO_2.

[Table/Fig-2]: Symptoms list, goals and physiotherapy treatment [1-4].



[Table/Fig-3]: Re-inflation of the left lung immediately after the 3rd session of physiotherapy.

DISCUSSION

Atelectasis occurs when the extremely small airways partially or completely collapse, leading to impaired gas exchange between CO_2 and O_2 [5,6]. Compressive atelectasis, resorptive atelectasis, and impaired synthesis or function of pulmonary surfactant are three mechanisms that can cause atelectasis [7].

Impaired airway clearance, airway obstruction, lung compression, and parenchymal lung disease can all result in impaired gas exchange in children. Complete airway obstruction due to inflammation can lead to atelectasis, while consistent partial obstruction can cause air trapping and hyperinflation. Mucosal plugging, bronchoconstriction, respiratory muscle or abdominal deficits, as well as compromised cough reflex due to anesthesia, can all contribute to this obstruction. The most common cause of atelectasis in children is infection or lung diseases like pneumonia [5,6].

A clinical diagnosis of atelectasis is typically made in patients with established risk factors. Imaging techniques such as chest X-ray, chest CT, and/or thoracic ultrasound can be helpful in identifying atelectasis if necessary. Chest X-ray can reveal changes in the lungs, such as opacity, and/or shifting of the airways to the affected side [5,8].

This case study demonstrates the effectiveness of physiotherapy treatment for an infant with total atelectasis. Cardiorespiratory physical therapy in newborns optimises secretion clearance, gas

Sessions	Pre-Vitals	Post-Vitals	Progression
Session 1 Day 1-12:00 pm Duration: 30 minutes-40 minutes Repetitions: Three rounds of intervention respective to the goals.	RR-60 breath/minute SpO_2-85% FiO_2-100%	RR-54 breath/minute SpO_2-88% FiO_2-100%	Reduction in added breath sounds and improved expectorant during suctioning.
Session 2 Day 1-4:00 pm Duration: 30 minutes-40 minutes Repetitions: Three rounds of intervention respective to the goals.	RR-57 breath/minute SpO_2-87% FiO_2-60%	RR050 breath/minute SpO_2-95% FiO_2-60%	Increased air entry over left lung with an increase in the number of spontaneous breaths.
Session 3 Day 1-8:00 pm Duration: 30 minutes-40 minutes Repetitions: Three rounds of intervention respective to the goals.	RR-50 breath/minute SpO_2-93% FiO_2-60%	RR-44 breath/minute SpO_2-98% HFNC-30%	Baby extubated and shifted to HFNC mode. Increased in the air entry.
Session 4- Day 2-10:00 am Duration: 20 minutes-30 minutes Repetitions: Two rounds of intervention respective to the goals.	RR-38 breath/minute SpO_2-98% HFNC 30%	RR-33 breath/minute SpO_2-100% HFNC 30%	Baby regained consciousness, clear lung sounds, maintaining vitals in HFNC mode and supported bed mobility initiated.
Session 5 Day 3-10:00 pm Duration: 20 minutes-30 minutes Repetitions: Two rounds of intervention respective to the goals.	RR-30 breath/minute SpO_2-100% HFNC 30%	RR-28 breath/minute SpO_2-100% Nasal prongs 2 litre	Oxygenation through nasal prongs initiated as vitals were maintained. Air entry was normal in bilateral lungs.
Session 6 and 7 Day 4&5-10:00 pm Duration: 15 minutes-25 minutes Repetitions: One round of intervention respective to the goals and home program was given.	RR-25-28 breath/minute SpO_2-100% Nasal prongs 2 litre	RR-25-28 breath/minute SpO_2-100%	Baby shifted to ward, maintaining saturation and tidal volume. Displays good rate and depth of respiration. Later baby was discharged with home program to improve expectoration and aeration further.

[Table/Fig-4]: Summary of patient progress after physiotherapy referral.

exchange, lung activation, and assists with weaning from artificial ventilation in the intensive care unit [9,10]. A survey conducted in 25 PICUs in Punjab, India, showed that 90% (76/84) of respondents reported using percussion as the most common chest physiotherapy treatment [11].

According to McAlinden B et al., electrical impedance tomography has shown that manual methods combined with suction can significantly alter ventilation distribution in infants compared to suction alone. These alterations may indicate recruitment of atelectatic alveoli, as there are no suitable end measurements to assess changes in ventilation dispersion [12].

Several studies have reported a statistically significant improvement in respiratory compliance and resistance in children after physiotherapy treatment with chest wall vibration and mechanical hyperinflations [13-16]. The current case report highlighted the significant improvement in the infant's condition following physiotherapy in the PICU. Future studies could focus on employing physiotherapy techniques in a larger population to evaluate their impact on ventilatory parameters. Reduction in respiratory resistance after physiotherapy compared to suctioning alone has also been documented in several studies [13-16].

CONCLUSION(S)

The present case report demonstrates that frequent and vigorous chest physiotherapy sessions have resulted in a significant improvement in the infant's condition within seven sessions. Despite using traditional chest physiotherapy techniques, the impact on the outcome was substantial. The infant's lungs re-expanded with increased alveolar recruitment within eight hours, thanks to appropriate physiotherapy treatments, leading to rapid recovery and early discharge. This suggested that physiotherapy plays a vital role in paediatric critical care, ensuring positive prognosis and faster recovery. Future studies can focus on developing standardised protocols that provide uniform treatment for specific age groups and diseases.

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