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RESEARCH ARTICLE

COMPARISON OF MANUAL HYPERINFLATION TECHNIQUE AND CONVENTIONAL CHEST PHYSIOTHERAPY TREATMENT IN CASE OF VENTILATED PEDIATRIC PATIENT

***Pradip Kumar Sarkar and Manvika Thakur**

PGIMER Chandigarh, India

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***Corresponding Author:**
Pradip Kumar Sarkar

ABSTRACT

Objectives: to investigate the effect of manual hyperinflation (MH) in patients with atelectasis associated with ventilation support. ***Design:*** patients were randomized to either an experimental group or a control group. Setting: paediatric Intensive Care Unit (ICU) from Post Graduate Institute of Medical Education and Research. ***Patients:*** 30 paediatric patients with atelactasis associated with ventilation support. ***Interventions:*** The experimental group received Manual hyperinflation in a group of 6 to 10 inflation using 350 ml to 500 ml of reusable manual Ambu bag with conventional chest physiotherapy. The control group received only conventional chest physiotherapy. ***Results:*** there were significant improvements in the scores over the 7 day study in the experimental group compared to the control group in ABG and chest radiographs and a trend towards improvement of tidal volume (VT) and respiratory rate. ***Conclusion:*** MH performed on patients with atelectasis on ventilation support had significantly improved alveolar recruitment.

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INTRODUCTION

The term atelectasis or lung collapse literally means imperfect expansion and is applied specially to failure of the lungs to expand fully. This condition was first described by Laennec in 1819.[1] Atelectasis causes a decrease in compliance in association with loss of volume, decreased oxygenation from venous admixture, and hypoventilation in severe cases. Patchy atelactasis is the hallmark of most infectious pneumonias in toddlers. When lobar collapse occurs in association with infection in infants, the right upper lobe is most commonly involved.[2] Lung collapse or atelactasis is frequently found in the critically ill patient and particularly those admitted in the ICU. Paediatric populations are more prone to develop this complication because of their small lung volume and less gas exchange area. This condition gets worse if the patients are on mechanical ventilators. It is the most common postoperative pulmonary complication. Thoracic and upper abdominal surgery can result in pain, splinting and a shallow monotonous breathing pattern resulting in atelectasis.[3] Treatment is primarily directed at reversing the underlying contributing mechanism whenever possible. The most effective therapy for atelectasis is the use of respiratory maneuver that increases inspiration and let the patient hold the inspiratory breath to allow the inspired gas to enter collapsed alveoli through the pores of Kohn.[4] MH was first documented more than 30 years back as a physiotherapy technique by Clement and Hubsch (1968). Then it was described as 'bag squeezing' method and said to be a highly effective technique to clear bronchial secretions and reinflate areas of collapsed lung. It was performed by an anaesthetist and physiotherapist in conjunction with appropriate positioning of the sedated patient, vibratory compression of the chest on expiration and endotracheal suction.[5]

Intermittent Positive Pressure Breathing (IPPB), blow gloves, and incentive spirometer are all equivalent in their ability to treat atelactasis, to decrease hospital stays, and to respiratory failure. For individual on ventilators, judicious use of continuous distending airway pressure of 4-6 cm H_2O help to overcome an atelactasis from increased surface forces as in Respiratory Distress Syndrome (RDS), some pneumonias and pulmonary edema.[6]

Need of the study: The need of the study is reasonable and prudent to minimize the peak airway pressure as much as possible during MH technique or any other ventilatory support procedure. he study examines the effect of Manual Hyperinflation in patient with atelectasis associated with ventilation support.

METHODOLOGY

Setting: Paediatric intensive care unit (PICU) of PGIMER, Chandigarh.

Inclusion criteria: All patients of 6 month to 5 years of age group and on mechanical ventilation with lung collapse confirm on Chest X-Ray were selected for the study.

Sample: 30 subjects suffering from lung collapse has been selected. Subjects been randomly allocated into two equal groups i.e. Group-A (experimental group) and Group-B (control group). Each group consisted of 15 subjects.

Group A- Experimental group: (n=15), Manual Hyperinflation Technique and conventional chest Physiotherapy treatment.

Group B- Control group: (n=15), Conventional chest physiotherapy treatment alone.

Exclusion criteria

- Patients with raised ICP
- Trauma to the lung tissue
- Pneumothorax without an intercostal drainage
- Pulmonary embolism
- patients with exacerbation of asthma
- patients with severe congenital heart disease

Dependent variable: Following variables were measured prior to procedure and at the end of the every session of treatment of the subjects:-

- ABG analysis
- X-Ray
- Air entry in the lung

Independent variable

- Manual hyperinflation
- Percussion
- Vibration
- Positioning
- Suction

Protocol

The techniques used for both groups were as follows

Manual hyperinflation (MH) technique was employed by the physiotherapist as per standard methodology in intensive care unit (ICU) or in any to remove excess bronchial secretions and to reinflate collapsed lung in the intubated patient[7]. It is a technique which provides a greater than baseline tidal volume to the lungs using an Ambu bag or manual resuscitor.[8] The experimental group received Manual hyperinflation in a group of 6 to 10 inflation using 350 ml to 500 ml of reusable manual Ambu bag. The ambu bag was being connected to a flow of 100% O_2. Suction via an endotracheal tube or Tracheostomy was used with the aim of removing secretions from the central airways and stimulating the cough reflex. Airway suctioning of endotracheal tube was carried by using 6 to 8 FG (French Gauge) catheter after end of chest physiotherapy and MH procedure or as required to clear the secretion for Paediatric patient. Aseptic technique is employed for suctioning, hands are washed before and after the procedure, and a sterile glove and sterile catheter are used. When the patient was attached with monitor, all the parameters were noted throughout the procedure i.e. E.C.G; B.P; H.R; R.R; I.C.P; Pulse etc. The vacuum settings of 50 to 100 mmhg was used for suctioning the endotracheal tube for the Paediatric patient.[9] Ethical committee approval was taken from the respective authority.

For group A (experimental group), at the beginning of the treatment session, first patient's pre treatment readings were recorded which included Ph value, PaO_2, SaO_2 and CO_2. Positioning of the patient was done with effected lung on elevated position. The experimental group first received Percussion, vibration and positioning. Percussion was performed manually by clapping the chest wall over the affected area of the lung using soft pediatric mask (rubber/silicon made), for 5 -7 percussion (frequency) in a group for 3-5 times in one session of treatment. Vibrations were applied manually by vibrating and shaking the chest wall during expiration for 3-5 vibration in a group for 3-5 times in one session of treatment.[10] After end of tracheal suction Manual hyperinflation was applied in a group of 6 to 10 inflation using 350 ml to 500 ml of reusable manual Ambu bag. The ambu bag was connected to flow of 100% O_2 to maintain O_2 saturation.

The bag was slowly compressed with both hands and inspiratory breath was maintained for 3 to 5 seconds at the end of pressing half of the bag and then completely pressing the bag. Expiration was passive and unobstructed to facilitate expiratory flow with no positive end expiratory pressure applied. Sufficient time was allowed for the Ambu to fill completely prior to the next breath. The Manual Hyperinflation procedure was carried out at a rate of 6 to 10 breath per min for a period of 10 min each session, two times daily for 7 days.

The control group (group B): Received percussion, vibration, positioning and suction same as that of the experimental group (except manual hyperinflation).

Time span of the study: 7 days for each patient.

RESULTS

There were 8 male and 22 female subjects in the study. All the patients had tracheal intubations with mechanical ventilation support. 12 subjects had tracheostomy. The average peak inflation pressure delivered ranged from 20 to 30 cm H_2O. These pressures were measured with the use of a standard circuit fitted with a valve designed to allow a maximum pressure of 60 cmH_2O.The pressure was maintained near about 20 cmH_2O to avoid pressure injuries.

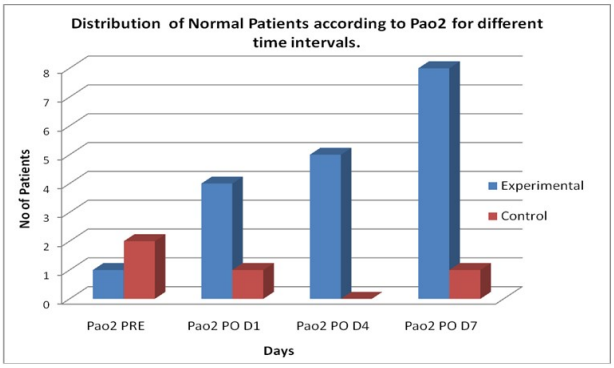

Figure 1.

No patients suffered barotraumas from either recruitment procedure. 30 patients were entered into the study. No untoward reactions to hyperinflation were noted. In the remaining patients, arterial pulse pressure, ICP, blood pressure (BP), ECG were fluctuating a little which returned to the baseline within few seconds.

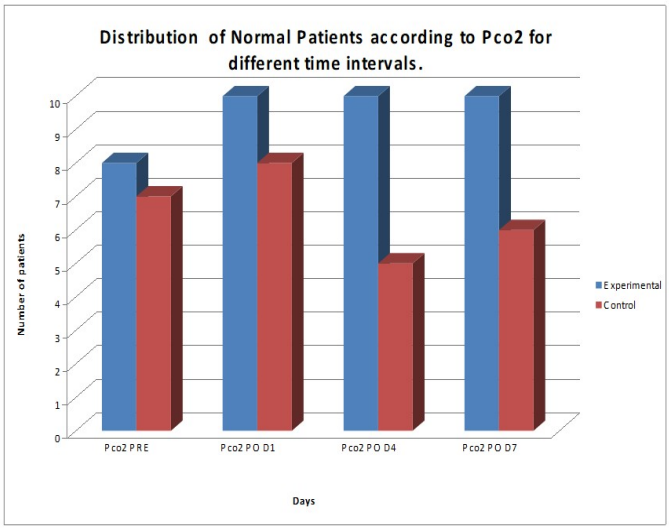

Figure 2.

Pretreatment and 3 post treatment outcomes of all the variables i.e. PaO_2, PCO_2, SaO_2 and Ph were taken into consideration of both group A and group B to observe the changes.

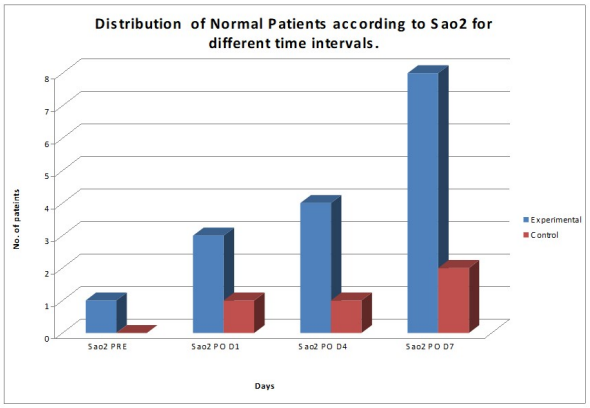

Figure 3.

Post treatment outcomes were measured on Day-1, Day-4 and Day-7. Differences between groups A (experimental group) and group B (control group) at each step in the protocol were determined by two way analysis of variance.

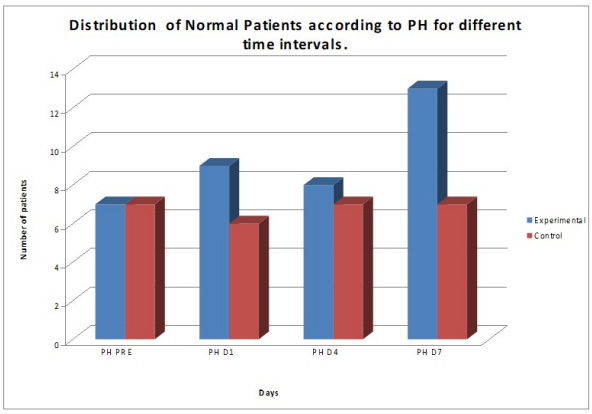

Figure 4.

Group A patients had a tendency to lower severity of illness than the group B patients in respect of all (i.e. Ph, PaO_2, SaO_2, CO_2, X-ray and air entry). Table-1 shows clearly that PaO_2 of experimental group improved 93.30%, i.e. much better than control group which showed improvement of 53.30%.The results obtained were statistically significant ($p<0.014$) in comparison to the pretreatment stage i.e. ($p<1.00$). Table-1 also shows that this improvement has been achieved gradually in the day wise treatment.

DISCUSSION

Manual hyperinflation is a widely used and accepted technique for treatment of the ICU patients[11]. Periodic hyperinflation may prevent deterioration of gas exchange in normal lungs that become acutely atelectic during mechanical ventilation, we could not demonstrate the ability of either standard hyperinflation or a sustained high pressure technique to improve gas exchange in our patient population with hypoxemic respiratory failure of more than or equal time duration.[12] In our study, it is found that the rate of improvement was gradual but steady. All the variables showed improvement from the day-1, which is maintained throughout the treatment duration. All the variables i.e. PaO_2, PCO_2, SaO_2, P_h, air entry and x-ray showed improvement from the day-1, and completed on day-7. All the variables showed significance of the improvement i.e. p value were less than or equal to 0.05. Maximum patients showed improvement in between day 4 and day 5.

Previous research in this field has revealed the potential for hypoxia during physiotherapy intervention. In this series, improved oxygenation occurred in all, except some patients, confirming that it is prudent to use 100% oxygen during manual hyperinflation. Periods of hyperinflation may be balanced by the periods during airway suctioning when there is no ventilation.[13] The accepted aim of manual hyperinflation for chest physiotherapy is to provide a tidal volume (VT) exceeding baseline VT, and using a VT that is 50% greater than that delivered by the ventilator, and requiring a peak inspiratory pressure of from 20-30 cm H2O. Although chest physiotherapy has been reported to produce a number of deleterious effects with the acutely ill patient, there no significant complications associated with its use in the present study.[14] The present study demonstrated a significant better rate of resolution of acute lobar atelactasis after every treatment intervention in patients who received manual hyperinflation, conventional chest physiotherapy and suction i.e. group A than the patients who received conventional chest physiotherapy and suction i.e. group B. At the end of seven days treatment this difference was much significant in our study. It was found that initially in the course of acute lobar atelactasis, the treatment of manual hyperinflation and suction was enhanced by the addition of positioning, vibration and percussion. Secretion clearance and improvement of oxygenation was much better in experimental group as compared to the control subjects. The study also showed marked reduction in atelactasis with stepwise inflation of the lungs that occurred only at an airway pressure greater than 20 cm H_2O.

An airway pressure of 20 cm H_2O results from approximately a doubling of the conventional tidal volume. Some studies show that the shunt in anesthetized patients was reduced successfully with a hyperinflation of the lungs. It was also shown that inflations to smaller pressures were not effective.[15] Manual hyperinflation of critically ill patients produce significant reduction in cardiac output, which may take up to 15 minutes to recover to baseline values. These falls in output are directly related to the degree of hyperinflation pressure. Large increase in intrathoracic volume impedes venous return which results in further fall of ventricular preload and cardiac output. The tidal volume generation is more crucial than airway pressure in compromising haemodynamic stability. Outcomes showed that the combination form of treatment i.e. of manual hyperinflation, conventional chest physiotherapy and suction improved air entry and lung compliance which resulted in reinflation of the collapsed area of the lung. This combination of treatment also helped to improve collateral ventilation of the lung and ultimately overall oxygenation and perfusion-ventilation of the lung.[16] Manual hyperinflation proved to be beneficial, as it promotes the ciliary's clearance of secretions, stabilization of the alveoli by redistributing the surfactant and collateral ventilation of the alveoli through pores of Kohn in the alveolar septa. The pores of Kohn open only during deep breathing. Same opening was done by manual hyperinflation which allowed air to pass from well ventilated alveoli, minimizing their tendency to collapse and facilitating obstruction removal. [17]

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