

# Comparative Effect of Proprioceptive Neuromuscular Facilitation (PNF) and Chest Physiotherapy with Chest Physiotherapy alone on SP02, Heart Rate, Respiratory Rate, & Lung Compliance in Mechanically Ventilated Patient

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## Abstract:

**Background:** Intensive Care Unit is a unit especially dedicated for the patients with life- threatening conditions, injuries or complications that specialize in management for the same. Mechanically ventilated patients usually present with larger amounts of pulmonary secretions because of impairment in mucociliary function and mucus transport. Intercostal stretch and anterior basal lift are techniques of proprioceptive neuromuscular facilitation which have beneficial effects among ventilatory patients.

**Objective:** To compare the efficacy of PNF and Chest Physiotherapy with Chest Physiotherapy alone on SPO<sub>2</sub>, HR, RR and Lung Compliance.

**Materials and Methods:** An Experimental (Interventional) Comparative Study was done. 30 participants from Intensive Care Unit (MICU) were included in the study and divided into two groups: Group A received PNF and chest physiotherapy & Group B received chest physiotherapy alone. Patients were given the intervention according to their allocated group for 5 days and effects of these techniques on RR, SpO<sub>2</sub> and HR and lung compliance parameters were observed. Data were taken at baseline and after 5 days of intervention.

**Result:** Independent t-test was taken for comparison of inter group data and paired t-test was taken for comparison of intra group data. Post-intervention Heart Rate, Respiratory Rate, Saturation of Oxygen, Lung Compliance parameter in both groups improved but Group A improved more significant than Group B.

**Conclusion:** The present study concludes that PNF alone with chest Physiotherapy are better and effective in improving saturation of oxygen, pulmonary compliance and reduction of Heart Rate, Respiratory Rate and lead to early extubation of patients.

**Keywords:** PNF in respiration, Chest physiotherapy, Mechanical ventilation

## INTRODUCTION

Intensive Care Unit (ICU) is a unit especially dedicated for the patients with life- threatening conditions, injuries or complications that specialize in management for the same. [1]

In developed countries, the mortality rate of patients on mechanical ventilation is increasing beyond 35% particularly in non-surgical patients requiring frequent ventilation. [3]

Patients in ICU are predominantly admitted for severe clinical manifestations. In special situations patients may also be kept for monitoring of vital signs like in post-operative cases or systemic abnormalities like hypertension. [2]

ICU management require continuous and vigilant medical care and physiotherapy care to keep patient chest clear and maintain mobility in bed ridden patients and also assist in weaning the patient off the ventilator. It is a team effort irrespective of specialty. [4]

Physiotherapists in ICU are involved in preventing functional impairment in the patient on mechanical ventilation support. It starts with detail assessment of the patient including history, current status, investigations and monitoring of vitals which go hand in hand during treatment and planning of treatment goals according to

patient condition. Physiotherapy is aimed at maintaining bronchial hygiene through positioning, percussion, vibration, mobilization, and endotracheal suctioning in order to prevent and reduce potential pulmonary complications such as hypoventilation, hypoxemia and infection and restore muscular and pulmonary function as far as possible. [5]

To mobilize and remove excess bronchial secretions and to reinflate collapsed pulmonary areas and improve oxygenation Physiotherapists often use a technique called lung hyperinflation which is also called as manual hyperinflation technique. [6]

Mechanical ventilation is required in patients who have difficulty or are unable to maintain normal physiologic function due to deterioration of lung parenchyma, disease states, and post-anesthesia recovery after surgical procedure causing respiratory failure. Indications for mechanical ventilation may vary from patient to patient that may include apnoea and impending respiratory arrest, acute exacerbation of COPD, cardiogenic shock etc. [7]

Utilization of mechanical ventilation extends from short term and long-term care in the hospital to care at home. There are many impediments associated with mechanical ventilation including pneumothorax, pneumonia, airway

injury, alveolar damage, and reduction in cardiac output, disuse atrophy of diaphragm and oxygen toxicity.<sup>[8]</sup>

Physiotherapy in critical areas are focused on reducing dependency on ventilators by uses of advanced, cost effective therapeutic modalities and interventions to enhance patient pulmonary functions and improve patient general condition, reduce hospital stay and maintenance airway clearance is very difficult in such patients and there is 60% increased chance of developing pneumonia.<sup>[9]</sup>

Prolonged mechanical ventilation often causes bio-trauma, barotraumas and volutrauma injuring the lungs and initiating a process called ventilator induced lung injury.<sup>[10]</sup>

Chest physiotherapy works by improving mucus clearance, decreasing the risk of pulmonary infection and thus enhancing quality of life. Viscous secretions, cuffed tracheal tube, dehydration, reduced normal respiratory efforts of the patient; hypoxemia, immobility and poor humidification all contribute to hamper mucociliary activity and impeding clearance of secretions. Optimum mucociliary activity and an effective cough are needed for normal airway clearance. Therefore, to bring improvement in pulmonary and hemodynamic parameters regular chest physiotherapy must be advocated. Even in absence of primary or significant lung disease chest physiotherapy is a key factor in respiratory care of mechanically ventilated patients.<sup>[11]</sup> Percussion and vibration are manual techniques of chest physiotherapy that are used for manipulation of thorax to apply intermittent kinetic energy to dislodge bronchial secretions.<sup>[12]</sup> It has been established that chest physiotherapy is beneficial in improving lung compliance and preventing lung collapsed.<sup>[13]</sup>

Proprioceptive Neuromuscular Facilitation (PNF) is a facilitator technique that can be used to improve chest wall mobility and thus improving expansion of chest. For restoring normal breathing pattern intercostal stretch is the most effective proprioceptive facilitator technique, other techniques include vertebral pressure to the upper thoracic spine, vertebral pressure to the lower thoracic spine, anterior stretch lift to the posterior basal area, moderate manual pressure, perioral pressure, abdominal co-contraction.<sup>[14]</sup> PNF lays base for the restoration of function by improving muscle strength, endurance, facilitate mobility, stability, control and coordinated movement.<sup>[15]</sup>

Combination of different techniques is part of physiotherapy practice in ICU with primary goal of removing secretion and no single technique alone can improve respiratory function.<sup>[16]</sup>

Therefore, the present study had been undertaken to determine the comparative effect of Respiratory PNF and chest physiotherapy with chest physiotherapy alone on Heart rate, SpO<sub>2</sub>, Respiratory rate and lung compliance in mechanically ventilated patients.

#### MATERIALS AND METHODS

An Experimental (Interventional) Comparative study was conducted on thirty participants (n=30, 12 Male and 18 Female) using random sampling. The study received approval from Institutional Ethical Committee Ref.No.

(DMIMS (DU)/IEC/2018-19/7200) . Participants who were mechanically ventilated with the age of 20-60 years were included according inclusion and exclusion criteria. The intervention was given twice in a day for 5 days for 25-30 min per session. Control group had conventional Chest Physiotherapy which included Vibration, Percussion, postural drainage and suctioning if indicated while experimental group had PNF technique of Intercostal Stretch and Anterior Basal Lift along with conventional Chest Physiotherapy. Each technique was repeated 10-12 times with 2-3 sets in supine lying position with 10 seconds of stimulus pressure and 10 seconds of rest for 3 days. The inclusion criteria for this study were both male and female participants, age between 20 to 60 years, Participants on mechanically ventilator in SIMV mode, Hemodynamically stable Participants. Exclusion criteria for the study were participants Rib fracture, chest trauma and Thoracic vertebra fracture and who underwent cardiac or abdominal surgery recently.

#### OUTCOME MEASURES

1. Compliance (mL/cmH<sub>2</sub>O)
  - a. Static compliance:
  - b. Dynamic lung compliance:

$$C_{STAT} = \frac{V_T}{P_{PLAT} - PEEP} \quad \text{Equation 5-5}$$

C<sub>STAT</sub> = Static compliance

V<sub>T</sub> = Tidal volume

P<sub>PLAT</sub> = Plateau (pause) pressure

PEEP = Positive end-expiratory pressure

$$C_{DYN} = \frac{V_T}{PIP - PEEP} \quad \text{Equation 5-6}$$

C<sub>DYN</sub> = Dynamic compliance

V<sub>T</sub> = Tidal volume

PIP = Peak inspiratory pressure

PEEP = Positive end-expiratory pressure

2. Respiratory Rate (RR)(breaths/min)
3. Saturation of oxygen (SpO<sub>2</sub>)%
4. Heart rate (HR)(beats/min)

#### DATA ANALYSIS AND RESULT

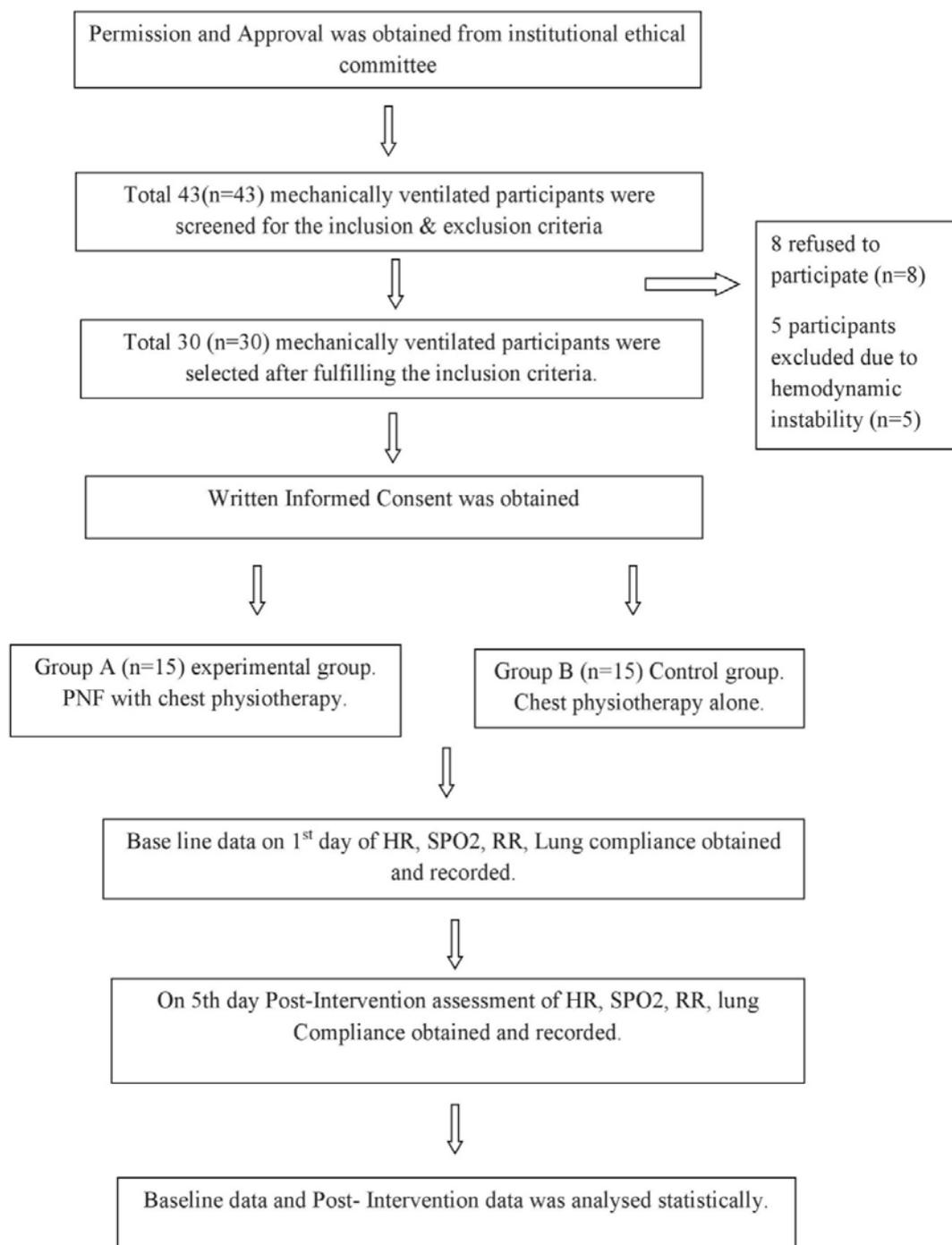
Statistical analysis was carried out utilizing SPSS version 22.0 Window software. Paired t test and unpaired t test were utilized to analyzed the data. Table 1 show Distribution of patients according to their gender. 33.33% of patients in group A and 46.67 in group B were males and 66.67% in group A and 53.55 in group B were females respectively

Heart Rate was calculated using post intervention data in both the groups (Table & Graph 2). The mean value of Heart Rate in Group A was 93.06 ± 8.51 and in Group B was 114.4 ± 12.25. By using Student's unpaired t test statistically significant difference was found in Heart Rate in at pre and post-test (t value = 3.16, \*\*\*P value = 0.0001).

Saturation of Oxygen was calculated using post intervention data in both the groups. The mean value of SPO<sub>2</sub> in Group A was  $99.6 \pm 0.62$  and in Group B was  $97.60 \pm 1.80$ . By using Student's unpaired t test statistically significant difference was found in SPO<sub>2</sub> in at pre and post-test (t value =4.05, \*\*\*P value =0.0001).

Respiratory Rate was calculated using post intervention data in both the groups. The mean value of Respiratory Rate in Group A was  $17.60 \pm 3.71$  and in Group B was  $23.46 \pm 7.20$ . By using Student's unpaired t test statistically significant difference was found in SPO<sub>2</sub> in at pre and post-test (t value =2.76, \*\*P value =0.01).

Compliance was calculated using post intervention data in both the groups. The mean value of Static Compliance in Group A was  $34.18 \pm 5.73$  and in Group B was  $23.76 \pm 7.70$ . The mean value of Dynamic Compliance in Group A was  $31.45 \pm 6.24$  and in Group B was  $21.42 \pm 7.64$ . By using Student's unpaired t test statistically significant difference was found in SPO<sub>2</sub> in at pre and post-test of Static compliance was (t value =4.20, \*\*P value =0.001) and Dynamic Compliance was (t value =3.93, \*\*\*P value =0.0001).



**Flow chart representing the procedure of selection of participants**

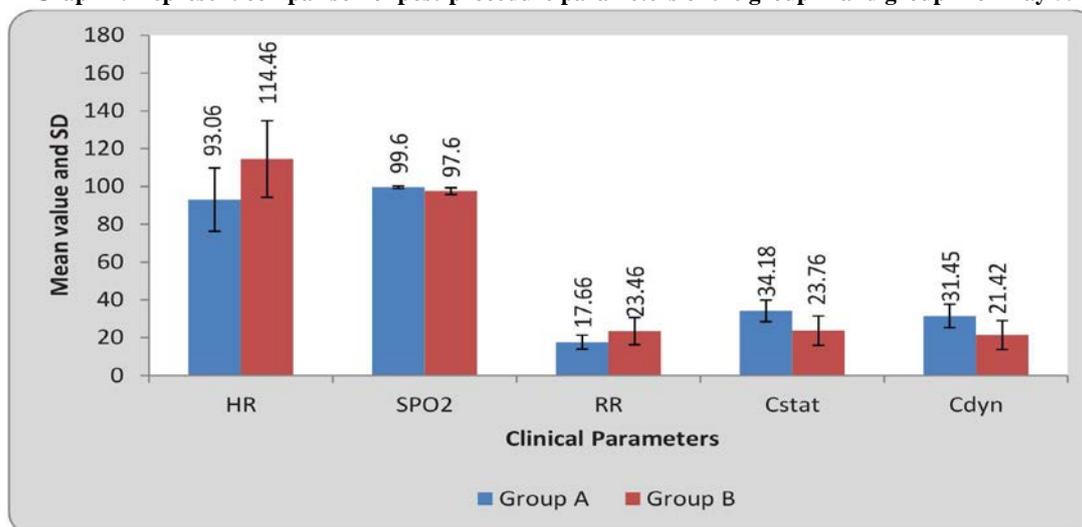
**Table 1: Demographic represent of gender wise distribution of participants in group A and B**

Gender	Group A	Group B
Male	5(33.33%)	7(46.67%)
Female	10(66.67%)	8(53.33%)
Total	15(100%)	15(100%)

**Table 2: Data represent comparison of post-procedure parameters of the group A and group B on Day 5. Student's unpaired t test**

Parameters	Group A		Group B		t-value	P-value
	Mean	SD	Mean	SD		
HR	93.06	8.51	114.46	12.25	3.16	P-value 0.0001,S
SPO2	99.60	0.63	97.60	1.80	4.05	P-value 0.0001,S
RR	17.66	3.71	23.46	7.20	2.76	P-value 0.010,S
Cstat	34.18	5.73	23.76	7.70	4.20	P-value 0.0001, S
Cdyn	31.45	6.24	21.42	7.64	3.93	P-value 0.001,S

\*S: Significant, \*HR –Heart Rate, \*SPO2-Saturation of oxygen, \*RR- Respiratory Rate, \*Cstat-Static Compliance, \*Cdyn- Dynamic Compliance.

**Graph 2: Represent comparison of post-procedure parameters of the group A and group B on Day 5.**

## DISCUSSION

The present study had focused on the comparative effect of Proprioceptive Neuromuscular Facilitation (PNF) and Chest Physiotherapy with Chest Physiotherapy alone on Heart Rate, Saturation of Oxygen, Respiratory Rate, and Lung Compliance conducted in Intensive Care Unit (Medicine ICU)

This study was designed as Single Blinded Randomized controlled trial. The total number of participants were n=30 in ICU on Synchronized Intermittent Mechanical Ventilation (SIMV) mode of ventilator.

PNF combined with Chest Physiotherapy are more efficient in enhancing Lung Compliance (Cstat, Cdyn) and Oxygen saturation (SPO2) and reducing or stabilizing the Respiratory Rate (RR) and Heart Rate (HR) of the consent participants.

**Dr. Sneha S Chordiya et al** conducted a study on the effect of respiratory proprioceptive neuromuscular facilitation chest physiotherapy technique in mechanically ventilated organophosphorus poisoning patients in which thirty patients were included with the history of OP poisoning. In post-conventional CPT, the value of pulmonary and hemodynamic parameters was compared and further after PNF, it was suggested that PNF

significantly enhance the value of CPT pulmonary and hemodynamic parameters in mechanically ventilated OP poisoning patients. The current research shows that after 5 days of intervention in mechanically ventilated patients, there was significant improvement in HR, RR, SPO2, and lung compliance.<sup>[13]</sup>

**Kumar Jithendra** research statement also supports our research outcome by suggesting that the ICU-based patient's PNF method shows enhancement in patient condition through decreased respiratory rate and heart rate, increased SPO2 and enables mechanical ventilation in early weaning.<sup>[17]</sup>

To generate reactions to reflex respiratory movement, a facilitator stimulus in the form of proprioceptive neuromuscular facilitation (PNF respiration) is well accepted. It changes breathing frequency and depth, enhancing compliance and thereby enhancing the exercise capacity. PNF methods are those involving the application of external proprioceptive and tactile stimuli producing reactions to reflex respiratory movement that appear to change breathing frequency and depth. PNF methods regularly used peri-oral stimulation, upper and lower thoracic spine vertebral stress, stomach co-contraction, intercostal stretch and anterior stretch basallift.<sup>[18]</sup>

The impacts of muscle mechanoreceptors, endings of muscle spindles and tendon organs are the proprioceptors involved in regulating the respiratory function level and timing. Muscle proprioceptors may also be involved in the early stage of exercise in rapidly increasing ventilation. Tendon organs are exposed to muscle contraction force changes and have an inspirational inhibitory impact. They may be essential during breathing when coordinating the contraction of the respiratory muscle.<sup>[18]</sup>

Respiratory drive is controlled by airways, lung and respiratory muscle information from sensory receptors as well as central and peripheral chemo receptors. Contraction and relaxation of the respiratory muscles is controlled by GOT (glutamic oxaloacetic transaminase), which is susceptible to muscle stretch ( active or passive), as a result of which there is a firing discharge of the muscle spindle, which gives this signal to CNS via Alpha and Gamma motor neurons directly responsible for initiating muscle contraction.<sup>[1]</sup>

Chest expansion is decrease due to decreased mobility of the chest wall and lung compliance. Intercostal stretching can increase chest wall elevation and thus enhance expansion to improve intra- thoracic volume of the lung which leads to an improvement in percentage flow rate. This can lead to increase ventilator ability such as tidal volume, minute ventilation, and oxygen status, thus increasing chest expansion, hyperinflation, and air trapping. The modification in ventilation parameters may be due to the firing release of the muscle spindle during a passive stretch. Intercostal stretching may have activated the stretch receptor in the chest wall, thereby distending the thorax that could be neurologically connected to the medulla with efferent nerve cells.<sup>[19]</sup> Advantage of application of PNF technique helps in lowering RR and HR along with, it also improves SPO<sub>2</sub> and lung compliance levels for ventilator weaning process thereby it is helpful in reducing the hospital stay of patient and social isolation.

Further research with other PNF techniques should be conducted in order to achieve a significant conclusion. Although there is limited data on anterior basal life technique of PNF. This technique was used in current study and was proved to be effective from the result obtained.

### CONCLUSION

The result of the present study showed improvement in Static, Dynamic compliance, Heart Rate, Respiratory Rate, Oxygen Saturation parameters after giving PNF along with Chest Physiotherapy than Chest Physiotherapy alone in mechanically ventilated patient.

The present study concludes that there was significant difference in both the groups A (experimental) & groups B (control).

### ETHICS CLEARANCE

It has been obtained by the Institutional Ethics Committee (DMIMS (DU)/IEC/2018-19/7200) of Datta Meghe

Institute of Medical Science, Deemed to be University, Sawangi (Meghe) Wardha.

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