# Effectiveness of Respiratory Proprioceptive Neuromuscular Facilitation（PNF） exercises on Respiratory Functions in Subacute Stroke Patients of SouthGujarat

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**ABSTRACT:**

**Introduction:** Stroke is one of the most common neurological disorders leading to chronic disability. The impairment in the skeletal system after stroke affects ,not only the peripheral muscles but can also cause a decrease in respiratory muscle strength, chest wall mobility and postural thorax dysfunction. In the early stages of the post-stroke period, anomalies in the respiratory system are not noticeable; however, with time, in cases of major muscle weakness, a significant decrease in the values of vital capacity（VC） and forced vital capacity（FVC） can be observed.

**Aim:** To check the Effectiveness of Respiratory Proprioceptive Neuromuscular Facilitation（PNF） exercises on respiratory functions in Subacute Stroke patients.

**Materials and Methods:** In the present experimental study, total of 34 patients were included; 17 patients per group with male and female having age between 40-70, first episode of stroke, Brunstrom recovery stage is =>3, MMSE=>24,Duration of stroke is between 6-18 months with no special pulmonary disease before the onset of stroke; those who had no innate deformation of the thorax or rib fracture; and those who were able to sit independently.Subjects having any neurological disorders other than stroke, sensory, perceptual disorder, communication problem, any known cardiovascular and musculoskeletal disorders were excluded. Subjects

were asked to perform set of exercises for five days a week with total duration of four weeks. Pre and post intervention assessment was carried out by using PFT. Paired t-test was used within group comparison; unpaired t test was applied between the groups.

**Results:** Both interventions were effective for stroke patients. Both the groups had a significant change for three outcome measures following four weeks of interventions, with $p<0.05$. The second group showed a significant improvement in respiratory function, with $p<0.05$.

**Conclusion:** Respiratory PNF has the positive effects on examined PFT parameters, which shows that this technique improves the respiratory functions in subacute stroke patients.

**Key Words:** Stroke, PNF respiration,FEV1,FVC,FEV1/FVC

## INTRODUCTION:

Stroke is one of the most common neurological disorders leading to chronic disability. It is an acute onset neurological dysfunction due to an abnormality in cerebral circulation with resultant signs and symptoms that correspond to involvement of focal areas of brain (1). Stroke or Cerebrovasular accident results in sudden specific neurological deficits (2). According to WHO stroke is "a focal (or at times global) neurological impairment of sudden onset, and lasting more than 24 hours (or leading to death) and of presumed vascular origin" (3). It is estimated that between the years 2005 and 2025, the percentage of stroke incidence will rise by 37% in men and 38%in women(4). Every year, stroke patients, related deaths, and disability-adjusted life-years are increasing, although the mortality rates for stroke have decreased in the last two decades(5). Stroke can affect individual's Motor and sensory function and also often affect the individuals' mobility, limiting their activities of daily living (ADL) and their social participation, and hindering their chances of resuming their professional life. Motor function among other factors (such as social or personal factors) could contribute to a low overall quality of life (QOL) and also reduce the level of functional independence(6). The impairment in the skeletal system after stroke affects not only the peripheral muscles but can also involve a decrease in respiratory muscle strength (7), chest wall mobility (8) and postural thorax dysfunction (9). Stroke patients' respiratory functions are directly/indirectly affected by declines in the oxygen transport related cardiovascular system functions and heart beat functions and decreases in paretic side chest wall movements and electrical activities (10) and the cardiovascular system functions decline remarkably due to reduction on the frequency of physical activities (11). Therefore, respiratory efficiency and changes in respiratory mechanism of patients reflect damage and asymmetry of thoracic wall can cause movement abnormality and muscular paralysis. In order to resolve these problems, chest wall expansion and ventilation and pulmonary volume and capacity should be appropriately maintained (12) and evaluation of functional

ability of the lungs through precise measurement of pulmonary functions, and diagnosis, prognosis, and degree of a disease may be made to obtain the ground for exercise prescription (13). Due to stroke individuals cardiorespiratory fitness will be reduced when compared with age- and sex matched healthy individuals (14, 15). Stroke can cause pulmonary disorders which are more closely related to life and lead to decline ability to adjust respiration, swallowing, as well as, language (16).

Since respiratory muscle weakening causes difficulties in breathing and declines in the ability to perform movements, therapeutic interventions that can improve respiratory muscle functions thereby relieving severely labored breathing and enhancing motion resistance such as ventilatory muscle training are required (17). In the early stages of the post-stroke period, anomalies in the respiratory system are not noticeable; however, with time, in cases of major muscle weakness, a significant decrease in the values of vital capacity (VC) and forced vital capacity (FVC) can be observed (18-20). McCool and Tzelepis advised that when initial stroke patients performed exercise at sufficient intensity to increase muscle strength, respiratory muscle strength and endurance increased so that eventual improvement in respiratory functions could be expected (21). Declination of lung function with the age can be measured by PFT. It is used to measure the rate at which the lung changes its volume during forced breathing maneuvers (22). A previous study in stroke patients noted that chest resistance exercises and diaphragmatic resistance exercises, by way of the proprioceptive neuromuscular facilitation (PNF) method, improved the subjects' pulmonary function, leading to expansion of the pulmonary tissue, improvements in thorax movement, strengthening of the respiratory muscles,and enhancement in endurance (23). Most commonly used parameters of PFT to assess lung function are dynamic flow rates i.e., forced expiratory volume in one second (FEV1), forced vital capacity (FVC) and FEV1/ FVC ratio, which are reported as % predicted compared with the individuals of same age, sex and height (24). The Proprioceptive Neuromuscular Facilitation technique is defined as a positive functional approach to help patients achieve their highest level of function. Breathing problems can be a result from both disturbed inspiration and expiration phases. To improve breathing, the related structures involving diaphragmatic, sternal and coastal areas should be treated (25). Seo KCperformed chest resistance exercises based on the PNF method, there wassignificant improvementin their gait ability, degree of chest expansion, and forced expiratory volume in 1second (FEV1) in stroke patients. (26) Proprioceptive Neuromuscular Facilitation (PNF) is a form of stretching in which a muscle is alternatingly stretched passively and contracted (27). The facilitatory stimuli are intercostal stretch, 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. Intercostal stretch is effective in restoring normal breathing pattern, proving beneficial in improving the chest wall mobility and thus improving chest expansion (28). Khedr et alnoted that the values of FEV1, FVC, and PEF in patients with focal brain damage were almost 2 times lower than inhealthypeople (29). There is scarce literature regarding respiratory Proprioceptive Neuromuscular

Facilitation（PNF） exercises on respiratory functions in subacute stroke patients． Hence, the aim of this present study is to check the effectiveness of respiratory proprioceptive neuromuscular facilitation（PNF） exercises on respiratory functions in subacute stroke patients．

**MATERIALS AND METHODS：-**TheExperimental Study was conducted on at various OPDs of Surat, Gujarat, India byPurposive sampling． Total 34patientswere includedin the study． The sample size was calculatedin G power 3．1．9．2 with effect size 0．50 and α = 0．05 at 80％ power． Sample size calculated was 40,with a drop out chances of 20％ the total sample size was 34,17 in each group．The inclusion criteria for study was male and female having age between 40−70, first episode of stroke, Brunstrom recovery stage is=>3, MMSE=>24,Duration of stroke is between 6−18 months with no special pulmonary disease before the onset of stroke; those who had no innate deformation of the thorax or rib fracture; and those who were able to sit independently．Subjects having any neurological disorders other than stroke, sensory, perceptual disorder, communication problem, any known cardiovascular and musculoskeletal disorders were excluded． In this study pen paper Chair with and without armrest, Consent form, Digital camera, and assessment sheets were used． Parameters of PFT（FVC, FEV1, FEV1/FVC ratio） were measured using Helios 401as an outcome measure．

**PROCEDURE：** −Ethical clearance was taken from the institutional ethical committee． The purpose of this study was explained and a written informed consent was obtained from all the subjects． Subjects were preliminary screened based on the inclusion and exclusion criteria and their demographic data were collected． They were allocated in two groups using quasi randomization in which the first patient was allocated to Group A and second to Group B．Group A were given conventional exercises which include Mat activities（stretching and strengthening）, Weight bearing or shifting and standing lower−extremity exercise in parallel bars and balance activities, Standing, Reaching, Transfers．Group B were given all conventional exercises mentioned in Group A and additional 20mins of respiratory PNF techniques which include（Peri−oral pressure,Vertebral Pressure,Co −contraction of abdomen,Intercostal Stretch,Anterior stretch basal lift）.On the first day of first week, pre−test measurement of FVC, FEV1, FEV1/FVC ratioby PFT were taken． Subjects of Group A were trained for 30 minutes each day and subjects of Group be were given 30mins of conventional activities and 20mins of additional respiratory PNF techniques． These treatments were given for five days a week for total four weeks． Five repetitions were demonstrated for each exercise． Then post measurementsof FVC, FEV1, FEV1/FVC ratioby PFT were taken after four weeks．

**STATISTICAL ANALYSIS：** −Statistical tests were performed using SPSS version 20．00 software． Significance level was set at $p<0.05$ for all analyses． Paired t−test was used for intra−group comparisons． Unpaired t− test was used for inter−group comparisons of FVC, FEV1, FEV1/FVC ratio．

**RESULTS:** - The study included 34 post stroke patients of which 22(64.71%) were males and 12(35.29%) were females. The mean age of was53.91±12.43. Participant baseline characteristics of Brunstrom and MMSE are given in [Table1]. Significance was set at p<0.05 for all analyses. The appropriate tool for comparison of the change in the level of a variable is student's paired t-test for intra-group comparison. For inter-group comparison unpaired t test was conducted. The results of the comparison of all the group participant with pre-test and post-test values of FVC, FEV1, FEV1/FVC ratioare presented in [Table-2,3]. The participants involved in the Group B who were given conventional exercises with additional respiratory PNF showed significant improvement (p<0.05) compared to Group A who were given only conventional exercises.

| | **Group A (Mean ± SD)** | **Group B (Mean ± SD)** |
|---|---|---|
| Age | 53.82 ±14.43 | 54.00 ± 10.52 |
| Height | 166.35 ± 2.84 | 163.17 ± 6.41 |
| Weight | 58.00 ± 3.72 | 56.64 ± 4.04 |
| BMI | 20.93 ± 1.38 | 21.30 ±2.02 |
| Brunstrom recovery Stage | 4.10 ±0.78 | 3.98 ±0.89 |
| MMSE | 27.90 ± 1.36 | 26.78 ±1.75 |

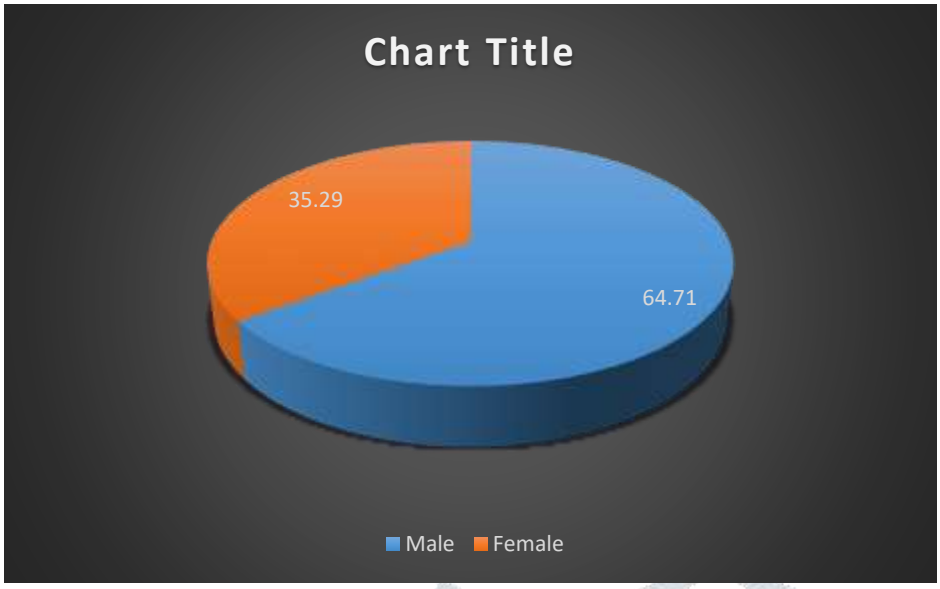
Table 1: Group wise Patients Baseline Characteristics

| **Group Name** | **Outcome Scale** | **Pre value** | **Post value** | **t-value** | **p-value** |
|---|---|---|---|---|---|
| A | FEV1 | 1.31 ±.042 | 1.49± 0.16 | -7.637 | .000 |
| | FVC | 1.34± 0.12 | 1.51± 0.14 | -10.224 | .000 |
| | FEV1/FVC | 80.99± 7.57 | 82.86± 6.33 | -5.495 | .000 |
| B | FEV1 | 1.47± 0.15 | 1.71± 0.17 | -12.997 | .000 |
| | FVC | 1.50± 0.15 | 1.86± 0.11 | -10.224 | .000 |
| | FEV1/FVC | 84.13± 7.17 | 87.74 ± 4.53 | -6.338 | .000 |

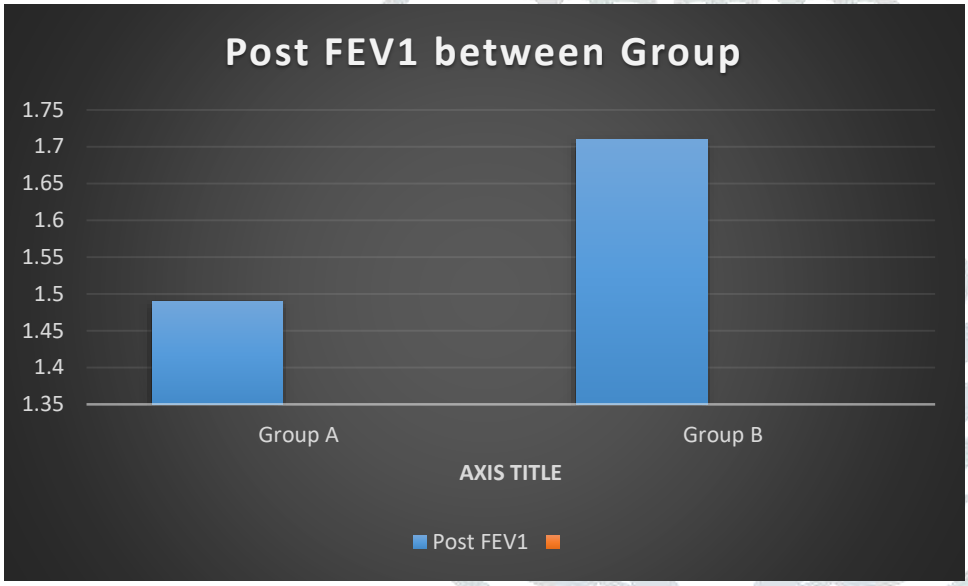
Table 2: Intra-group comparison of PFT parameters

| **Outcome Scale** | **Group A** | **Group B** | **t-value** | **P value** |
|---|---|---|---|---|
| Post FEV1 | 1.49± 0.16 | 1.71 ± 0.17 | -4.437 | 0.000 |
| Post FVC | 1.51±0.14 | 1.86 ± 0.11 | -7.523 | 0.000 |
| Post FEV1/FVC | 82.86 ±6.33 | 87.74± 4.53 | -4.048 | 0.035 |

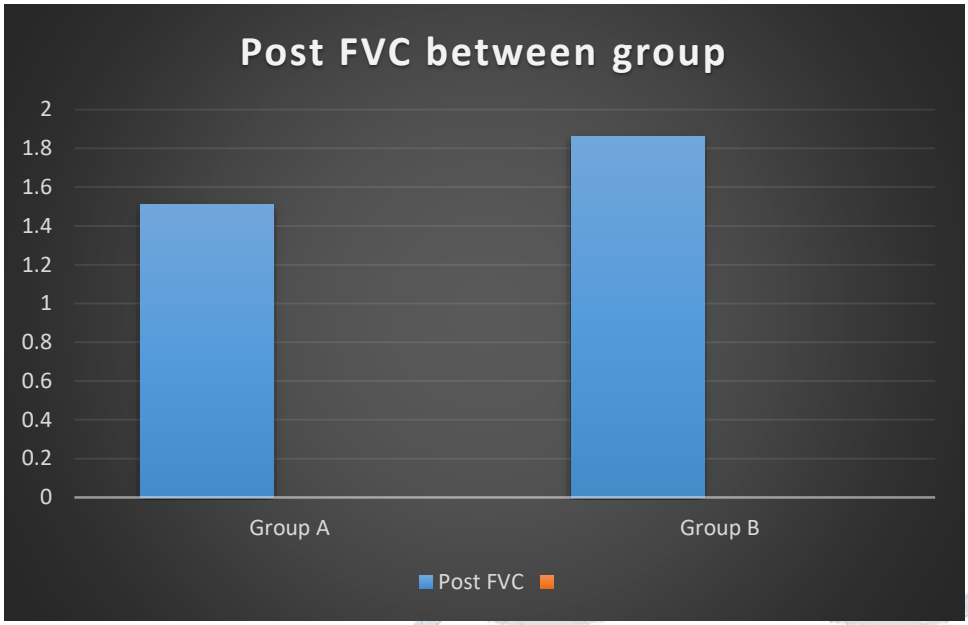
Table 3: Inter-group comparison of PFT parameters



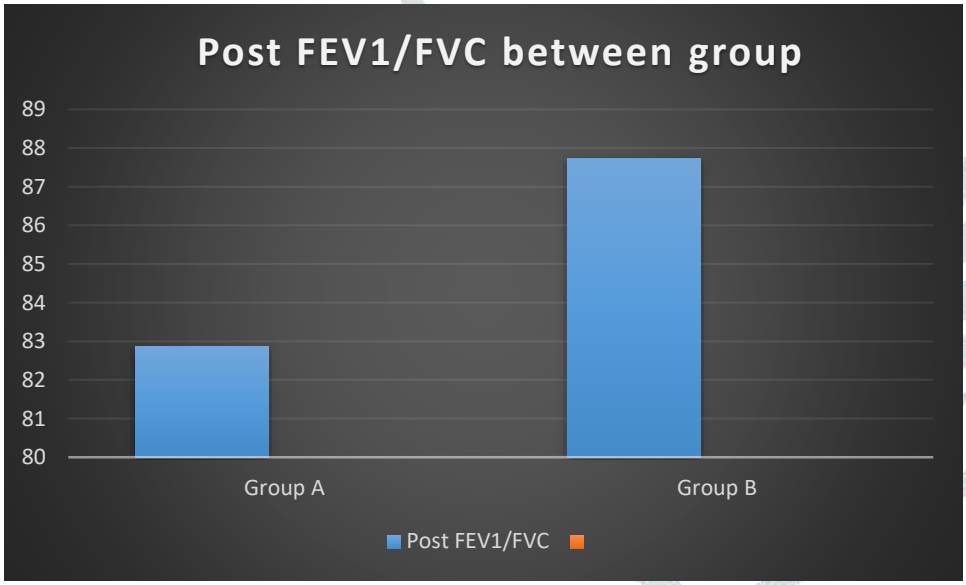

Graph 1 : Sex distribution




Graph 2 : Comparison of FEV1 between group




Graph 3: Comparison of FVC between group




Graph 4: Comparison of FEV1/FVC between group

**DISCUSSION**: -The present study results show that conventional physiotherapy training and Respiratory PNF with conventional physiotherapy both are effective as $p<0.05$ which shows highly significant. In PNF peri-oral stimulation, vertebral pressure of the upper and lower thoracic spine, co-contraction of abdomen, intercostal stretch and anterior stretch basal lift were used. Here pre and post values of different PNF parameters were compared and they have shown improvement. Mohammad Reza Hoseinabadistudied the effects of physical therapy on exaggerated muscle tonicity, balance andquality of life on hemipareticpatients due to stroke and concluded that the average balance andquality of life significantly improved among those

patients, and tonicity of muscle also decreased（30）. It was found that there was significant improvement in both the groups, as there was improvement in all three respiratory parameters. In a previous study,

Sutbeyaz classified stroke patients in a sub-acute state into an inspiratory muscle training group, a respiratory retraining group, and a control group, and applied interventions six times per week for sixweeks to compare pulmonary function between groups. The results showed that FVC and FEV1of the inspiratory muscle training group significantly increased.（18）. In another study by Mueller et al.16）, respiration exercises in spinal cord injury patients resulted in a significant increase in FEV1/FVC and FEV1 which supports our findings. （31）In Group B additional respiratory PNF showed significant improvement in respiratory parameters like FEV1, FVC and FEV1/FVC. The effects of the muscle mechanoreceptors, muscle spindle endings and tendon organs, are the proprioceptors participating in regulation of the level and timing of the respiratory function. Muscle proprioceptors may also involve in increasing the ventilation and increase in lung capacity. Tendon organs are sensitive to changes in force of muscle contraction and improve in coordination of respiratory muscle contraction during breathing（32）. Kyochul SEO et al showed that there was a significant improvement in TV, ERV, and VC after 4 weeks of Proprioceptive neuromuscular facilitation respiration pattern exercise in normal adults.（26）. All these results are similar to our findings. Researches also suggest that PNF can improve the chest expansion and mobility of chest muscles which are suggestive of our results.

**Limitations**: Sample size was small. In this study only 40-70year of age group were included so these findings cannot be applied to entire human population. In this study, the treatment duration was very less.

**CONCLUSION**:-In conclusion, it can be said that respiratory PNF has the positive effects on examined PFT parameters, which shows that this technique improves the respiratory functions in subacute stroke patients.

Clinical Implication: The clinical importance of current findings is that with the help of additional respiratory PNF techniques provided to subacute stroke patients we can improve ventilation, lung capacity and chest expansion which increase the respiratory fitness and improve QOL.

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