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IMMEDIATE EFFECT OF PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION (PNF) OF RESPIRATORY MUSCLES ON PULMONARY FUNCTION IN COLLEGIATE STUDENTS.

D.ANANDHI[*1] P.DEEKSHITHA[2] V.P.R.SIVAKUMAR[3]

[1]Associate Professor, SRM College of Physiotherapy, SRM University, Kattankulathur
[2]Student, SRM College of Physiotherapy, SRM University, Kattankulathur
[3]Dean, SRM College of Physiotherapy, SRM University, Kattankulathur

ABSTRACT

Respiratory muscle strength and endurance can be improved by various. Breathing exercises which can consequently improve respiratory function. Proprioceptive Neuromuscular Facilitation is a new technique to improve the respiratory function such as Tidal Volume (TV), Inspiratory Reserve Volume (IRV), Expiratory Reserve Volume (ERV), Inspiratory Capacity (IC), Vital Capacity (VC). To find out the Immediate effect of Proprioceptive Neuromuscular Facilitation (PNF) of respiratory muscles on pulmonary function in collegiate students. A quasi experimental study with one group pre test post test design was done. A sample of 30 including both men and women, with an age group between 18 and 28 years, Asian BMI 17.5 – 27.99 (underweight to overweight) were selected . Subjects who were obese, smokers, who had lung diseases, cardiac diseases, congenital chest deformities, who had recent surgeries in chest wall, subjects on any physical training programs were excluded. Outcome measures were Pulmonary Function Test–Tidal Volume, Inspiratory Reserve Volume, Expiratory Reserve Volume, Inspiratory Capacity, Vital Capacity which were taken before and 5 minutes after giving PNF technique. Forced vital capacity (FVC) showed significant increase of mean difference of 2.5434 with $p<0.05$ and Inspiratory capacity(IC) also showed significant increase of mean difference of 0.266 with $p<0.05$ after giving Proprioceptive Neuromuscular Facilitation. Inspiratory Reserve Volume, Expiratory Reserve Volume and Peak Expiratory Flow Rate (PEFR) were also increased but did not show significant increase. Though IRV, ERV, PEFR increased, only FVC and IC improved significantly immediately ($p<0.05$) after PNF to respiratory muscles.

KEYWORDS: *Tidal Volume, Inspiratory Reserve Volume, Expiratory Reserve Volume, Inspiratory Capacity, Vital Capacity , Proprioceptive Neuromuscular Facilitation.*

D.ANANDHI*

Associate Professor, SRM College of Physiotherapy,
SRM University, Kattankulathur

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INTRODUCTION

Breathing exercises intervention is to minimize disabilities resulting from diseases and to Prevent recurrence, rather than complete recovery from disease. Developing and applying Diverse programs that can prevent decrease in respiratory activities and promote the functional performance of breathing is very important[1]. Respiratory muscle strength and endurance can be improved by various breathing exercises which can consequently improve respiratory function[1]. PNF is a new technique to improve the respiratory function (IC,ERV,IRV,PEFR,FVC,TV)[2]. It is possible that short term effect of PNF stretching on muscle force production may affect the performance of various rehabilitation strengthening exercises[2]. PNF of respiratory muscles is the term used to describe externally applied proprioceptive and tactile stimulus that produces reflex respiratory movement. During inspiration and expiration, the inspiratory and expiratory neurons transmits impulses to the spinal respiratory motor neurons for intercostal, abdominal, and phrenic innervation. During sleeping and normal breathing the automatic centres are responsible for controlling breathing rate and volume. In case of manoeuvres such as speaking, coughing, singing and holding breath, cortical centres take over voluntary control of breathing. Outputs from mechanoreceptors and chemoreceptors in the respiratory system stimulate or inhibit the action of components of the respiratory centres[3]. During inspiration the rib cage moves up and out to increase the mediolateral and anteroposterior diameter of the chest. The expansion of the chest wall reduces the pressure in the lungs and creates a pressure differential that allows air flow into the lungs, in expiration the rib cage returns to its starting position by moving down and in to decrease the increased chest diameter[3]. PNF is done to diaphragm and accessory muscles of respiration. The diaphragm normally supplies the bulk of the inspired air during quiet breathing, so diaphragmatic breathing is the preferred pattern of breathing. However, after some neurological insults, strictly diaphragmatic breathing may not be possible or even preferred. So restoration of independent, efficient breathing patterns for such patients may require regular use of accessory muscles[4].

Proposed mechanisms of PNF stretching

Autogenic inhibition: which refers to the reduction in the excitability of a contracted or stretched muscle attributed to increased inhibitory input, and subsequently decreased efferent drive, arising from the Golgi tendon organs[5]. Reciprocal inhibition: which essentially refers to the inhibition that occurs in a muscle when there is a contraction of its antagonist[5].

Aim of the study

To find out the immediate effect of Proprioceptive Neuromuscular Facilitation of respiratory muscles on pulmonary function in collegiate students.

Need of the study

Very few studies are done on the effect of PNF of respiratory muscles over pulmonary function in normal or diseased population. Moreover this study is done to know whether the PNF technique has immediate effect on pulmonary function.

METHODOLOGY

Institutional Ethical Committee approval was obtained (IEC Ref.No. 0197). A quasi experimental study with one group pre test post test design was done. A sample of 30 including both men and women, with an age group between 18 and 28 years, Asian BMI 17.5 – 27.99 (underweight to overweight) were selected . Subjects who were obese, smokers, Physician diagnosed patients with known lung diseases and cardiac diseases, congenital chest deformities, who had recent surgeries in chest wall, subjects on any physical training programs were excluded. Subjects selected a were given a written informed consent. After collecting relevant demographic data, pulmonary function test (Spiro excel) was done before application of PNF technique and they were noted as pre-test values. PNF was given to the major muscle of respiration Diaphragm (Figure 1), two accessory muscles of respiration Sternocleidomastoid (Figure 2) and Pectoralis major (Figure 3). PNF for Diaphragm: Subject's position was supine without pillow, therapist placed her open hands on the lateral surface of both sides on the 8, 9, 10, 11 ribs of the subject. The therapist instructed the subject, "Take a deep breath". As the subject's ribs moved upward and laterally, the therapist assisted the movement of the subject's ribs to promote the subject's respiratory pattern. At the time of maximum inspiration, they have to hold the breathe for 5secs, and the therapist dorsomedially applying soft manual resistance to the lower rib regions on both sides. When the subjects breathed out, the therapist asked to, "Breathe out maximally". At this time the subject's ribs moved downward and medially. At maximum expiration, the therapist pushed the lower rib region on both sides upward while gathering the regions dorsomedially, and the therapist shook the region to assist with the discharge of the air remaining in the lungs[25] (Figure 1). PNF for sternocleidomastoid: the therapist placed the hands parallel to the trunk, so that the fingers were pointing up towards the neck rather than pointing out towards the shoulder, applies the stretch during inspiration and release during expiration(Figure 2). PNF for pectoralis major: the therapist placed the hands in the direction of the contraction of muscle fibers, diagonally placed on the upper thorax, the heel of the therapist hand should be near the sternum and the fingers aligned up and out toward the shoulder. The subject was asked to "Take a deep breath", applies the stretch during inspiration and release during expiration(Figure 3). After finishing the application of proprioceptive neuromuscular facilitation, pulmonary function test was taken after 5mins. The Pulmonary Function Testing is done with Spiro excel, with the patient comfortably seated in a chair. Forced Vital Capacity, Peak Expiratory Flow Rate, Inspiratory Reserve Volume, Expiratory Reserve Volume and Inspiratory Capacity of the subjects are obtained pre and post the application of PNF to respiratory muscles (Figure 4).

Figure1
PNF for Diaphragm

Figure 2
PNF for Sternocleidomastoid

Figure 3
PNF for Pectoralis major

Figure 4
Pulmonary Function Test

Outcome measures

1. Forced Vital Capacity in litres
2. Peak Expiratory Flow Rate in litres/min
3. Inspiratory Reserve Volume in litres
4. Expiratory Reserve Volume in litre
5. Inspiratory Capacity in litres.

Data analysis

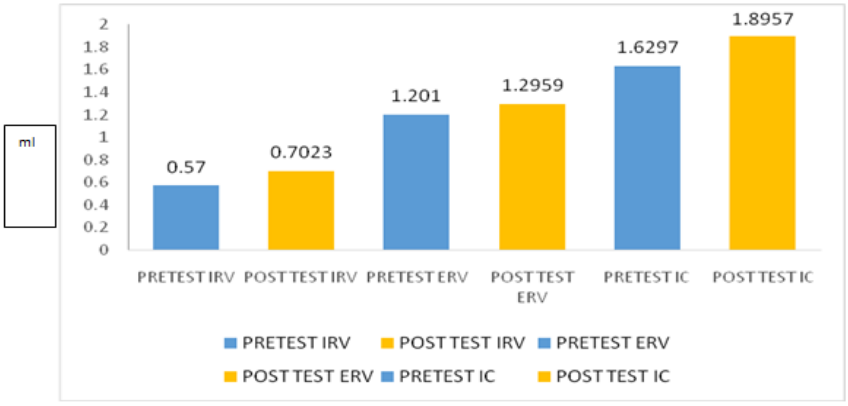
Forced Vital Capacity, Peak Expiratory Flow Rate, Inspiratory Reserve Volume, Expiratory Reserve Volume and Inspiratory Capacity of 30 subjects were obtained by using computerized Pulmonary Function Test, pre and post the application of PNF to respiratory

muscles. The data obtained was tabulated and statistically analysed using the SPSS 17. The mean and standard deviations of all the variables were analysed. Paired 't' test was used to find the effect of PNF of respiratory muscles on Pulmonary Function within a single group of collegiate students and the result were considered if $p<0.05$.

Table 1
Comparison of pre and post-test mean values of FVC, PEF, IRV, ERV, IC after PNF to respiratory muscles(N=30)

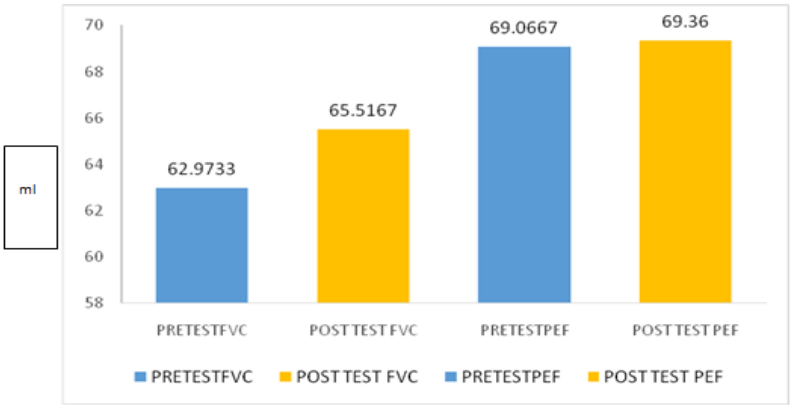
Para meters	Pretest Mean(SD)	Post test Mean(SD)	Mean Difference ±SD	Significance (t Value)	P Value
FVC	62.9733±11.63096	65.5167±12.38812	-2.54333±4.67559	2.979	.006
PEF	69.0667±27.33363	69.3600±32.98193	-.29333±15.49632	.104	.918
IRV	.5700±.47107	.7023±.50810	-.13233±.34072	2.127	.042
ERV	1.2010±.60274	1.2957±.60162	-.09467±.22448	2.310	.028
IC	1.6297±.69307	1.8957±.66923	-.26600±.45249	3.220	.003

(p<0.05)
Forced Vital Capacity (FVC),Peak Expiratory Flow (PEF), Inspiratory Reserve Volume (IRV), Expiratory Reserve Volume (ERV), Inspiratory Capacity (IC)



(p<0.05)
Pretest and Posttest values of Inspiratory Reserve Volume(IRV),Expiratory Reserve Volume(ERV),Inspiratory Capacity(IC)

Figure 5
Comparison of pre and post-test mean values of IRV, ERV, IC after PNF to respiratory muscles



(p<0.05)
Pretest and Posttest Values of Forced Vital Capacity (FVC), Peak Expiratory Flow (PEF)

Figure 6
Comparison of pre and post test mean values of FVC AND PEF after PNF to respiratory muscles

According to table 1: Comparison of pre and post-test mean values of FVC shows that there is statistically significant increase in mean value of pre-test from 62.973 to post-test value 65.5167 with p=0.006. Comparison of pre and post-test mean values of PEF shows that there is increase in the mean value of pre-test from 69.0667 to post-test value 69.3600. But in this p=0.918 which states that there is no statistically significant increase between pre and post-test. Comparison of pre and post-test mean values of IRV

shows that there is increase in the mean value of pre-test from 0.5700 to post-test value 0.7023. But in this p=0.042 which states that there is no statistically significant increase between pre and post-test. Comparison of pre and post-test mean values of ERV shows that there is increase in the mean value of pre-test from 1.2010 to post-test value 1.2957. But in this p=0.028 which states that there is no statistically significant increase between pre and post-test. Comparison of pre and post-test mean values of IC shows that there is statistically significant increase in the mean value of pre-test from 1.6297 to post-test value 1.8957 with p=0.003.

DISCUSSION

30 subjects were selected according to inclusion and exclusion criteria, pre-test values of FVC, PEFR, ERV, IRV, IC were noted before the intervention, then proprioceptive neuromuscular facilitation stretch to diaphragm and accessary muscles is applied and again the post –test values were obtained to find out the acute effects. Some articles were shown that PNF stretch for long period that is more than 60 seconds shows decrease in the muscle strength immediately after the stretch[6]. Many studies have found acute decreases in strength following PNF stretching, and that such decreases seem to be more prominent the longer the stretching protocol, the number of exercises and sets, and the duration of each set have, in general, exceeded the ranges normally recommended in the literature[6]. This study shows increase in the pre and post –test mean values of FVC, PEFR, IRV, ERV and IC. It can be because each PNF stretches were given for 15 seconds and hence there was no reduction of muscle strength and it shows increase in the pulmonary function. According to Kyochul Seo the tidal volume and inspiratory capacity were increased after applying the PNF technique to the respiratory muscles.[1] In our study also it proves there was a statistically significant increase in Inspiratory Capacity after performing PNF technique to respiratory muscles. Peak Expiratory Flow Rate (PEFR) had no significant increase after the proprioceptive neuromuscular facilitation, it may due to the fact that PNF was only applied to the inspiratory muscles and not to the expiratory muscles. Enright *et al*., reported that vital capacity, inspiratory capacity, muscle strength, and inspiratory muscle endurance were significantly increased by high frequency inspiratory training performed by normal persons[1]. Estenne *et al*., reported an increase of 47% in expiratory reserve volume in quadriplegia patients when they performed pectoralis major muscle strengthening exercise[1]. The physiological mechanism that facilitates the initiation of inspiration is thought to be the stretch reflex. The stretch reflex resists the change in muscle length by contracting to stretched muscle via its muscle spindle (proprioceptor). Generally, PNF technique continues with repeated stretch through range to facilitate an increase in inspiratory volume. Appropriate resistance during applying one of the PNF techniques strengthens the muscles and guides the chest motion [7, 8]. In a study by Minoru Ito,Respiratory Muscle Stretch Gymnastics for one session had an immediate effect of changing respiratory pattern into slower and deeper pattern.[9]Joint mechanoreceptors are sensitive to movement of chest wall and likely to influence the level and timing of the respiratory activity. Afferents of proprioceptors affect the firing rate of phrenic motor neurons via their projections. In addition they project to the medullary respiratory group and influence the timing of inspiration and expiration. Further studies can be done to evaluate long term effect of PNF on respiratory muscles which may improve IRV, ERV, PEFR statistically.

CONCLUSION

Proprioceptive Neuromuscular Facilitation to respiratory muscles shows an immediate improvement in FVC and IC thus shows an enhanced lung function among collegiate students.

CONFLICT OF INTEREST

Conflict of interest declared none.

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Reviewers of this article

Mrs. V. Mahalakshmi, MPT

Professor / PSG College of Physiotherapy, Peelamedu, Coimbatore, India

Prof. Y. Prapurna Chandra Rao

Assistant Proffessor, KLE University, Belgaum, Karnataka, India

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