

Effect of proprioceptive neuromuscular facilitation on core strength in healthy females: An experimental study

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Abstract

Context: Core muscles provide accurate proprioceptive information. Altered neuromuscular control is a predisposing factor in LBP. The core muscles are multifidus, rotators, transverse abdominis, internal oblique and quadratus lumborum.

Aims: To examine the effects of 2 commonly used PNF techniques, on core strength in healthy females for prevention of low back pain and reduce the risk of injury.

Settings and Designs

Methods and Material: Primary data collection was done using computerized randomized sampling, 50 healthy females between the age group of 18-25 years were taken based on the selection criteria and informed consents were obtained. PNF techniques were given to the participants within a period of 4 weeks and core strength was measured by aneroid sphygmomanometer and one minute sit up test before and after 4 weeks of intervention. Data were analyzed using paired sample t-test and Wilcoxon test.

Statistical analysis: The pre test mean of core strength using sphygmomanometer was 6.47 ± 3.13 and post test was 16.25 ± 4.49 which was statistically significant ($p < 0.001$) ($t = 18.153$). The pre test mean of one minute sit up test was 22.77 ± 4.40 and post test was 32.49 ± 4.65 which was statistically significant ($p < 0.001$) ($z = -5.981$) at the end of the 4 week period.

Conclusion: The result of the study shows that the application of 4-week PNF programs has significant effect on core strength in healthy females.

Keywords: healthy females, core strength, pnf, sphygmomanometer, one minute sit up test

Introduction

Core has to be functionally effective to use the strength, power and endurance as individual develop^[1]. The "core" has been described as a box with the abdominals in the front, paraspinals and gluteals in the back, the diaphragm as the roof, and the pelvic floor and hip girdle musculature as the bottom^[2]. It is known that if the core is not stable, then the weaker links within the kinetic chain are at risk for injury^[3].

Parashar P *et al.* studied on prevalence of low back pain due to abdominal weakness in collegiate young females between age group of 18-25 years and found that out of 76 subjects 47.3% were suffering from weakness of trunk flexors and 52.6% were suffering from weakness of trunk rotators and shows that abdominal weakness has a major role in low back pain.

All local stabilizer and global mobilizer core muscles were recruited before any extremity movement, indicating that core muscles provide proximal stability for distal mobility^[4, 5, 6]. The decreased core stability has been suggested to contribute to the etiology of lower extremity injuries in female^[7]. Altered neuromuscular control is a predisposing factor in LBP^[8, 9, 10] Core strengthening helps to prevent and rehabilitate various lumbar spine and musculoskeletal disorders^[11]

Proprioceptive neuromuscular facilitation was developed by Herman Kabat, along with the American physiotherapist Margaret Knott, in the 40's. PNF exercises are designed to enhance the response of neuromuscular mechanisms by stimulating the Proprioceptors. PNF has been recommended for sensory-motor control training, as well as for stimulating lumbar muscle proprioception^[12]. Two commonly used forms

are rhythmic stabilization training (RST) and combination of isotonic exercises (COI).

The RST technique uses isometric contraction of antagonistic patterns and results in co-contraction of the antagonists if the isometric contraction is not broken by the physical therapist^[13].

The COI technique involves the performance of alternating concentric, eccentric, and isometric contractions and is used to treat deficiencies in strength and range of motion^[14].

Objective

Effect of Proprioceptive neuromuscular facilitation [PNF] technique on Core Strength in healthy females.

Materials and Methods

Subjects were taken from different institutes of Parul University. 50 female students were selected after screening as per the inclusion and exclusion criteria using computerized randomized sampling and those willing to receive intervention of 20 sessions for 4 consecutive weeks duration, briefed about the nature of the study and informed consent was taken. Females students of Age-18-25 Years, BMI - 18.5-25 (normal range), one minute sit up test range - very poor (<18), poor (18-24), below average (25-28) and students who are not participating in any other strengthening program were included in the study.

In our study, pregnant females, females with any acute pain, any acute injury, trauma or illness, any neurological, cardiopulmonary, psychiatric, gynecological conditions and congenital abnormalities were excluded.

The training frequency was 5 times per week and no training sessions on first three days of menstrual cycle.

Subjects were performed standardized warm-up exercises (stationary bicycling and stretching exercises for 7-10 minutes) and cool-down exercises as a part of each training session.

Treatment session consist of PNF techniques for trunk which includes-Rhythmic Stabilization training (RST) and Combination of Isotonic (COI) exercises.

The training volume per session includes 3 sets of 15 repetitions. Exercise was performed with the subject in a seating position facing the physical therapist. Resistance was provided by the physical therapist by placement of the hands on the upper part of the chest (for trunk flexion) or the scapula-shoulder region (for trunk extension).

Each treatment session was conduct for 30-45 minutes, with a total of 20 treatment sessions within 4 weeks.

Before and after 4 weeks of intervention, core strength was measured using an aneroid sphygmomanometer and one minute sit up test and the results were analyzed.

Rhythmic Stabilization Training

The RST program consist of alternating (trunk flexion-extension) isometric contractions of antagonists against resistance for 10 seconds, with no motion intended^[13]. Total duration of 1 repetition is 10 s and 1 session (including rest intervals) is 10 min.

Subject assumes a seated position and faces the physical therapist. The therapist places her hands on upper part of the thoracic area, just below the shoulder level. From this position, the subject is instructed to flex the trunk against resistance provided by the therapist. The resistance slowly increases as the subject gradually increases strength. When strength exertion is stabilized, the therapist slowly moves one hand to the upper part of the back, just below the shoulder level, aiming to provide resistance to the antagonist movement of the trunk (10 s).When the subject responds to the new position, the therapist moves the other hand to the upper part of the back and instructs the subject to extend the trunk against the resistance provided.

Subjects were performed 3 sets of 15 repetitions at maximal resistance provided by the same physical therapist.

Rest intervals of 30 seconds and 60 seconds was provided after the completion of 15 repetitions for each pattern (between each sets) and between each techniques, respectively.^[15, 16]

Combination of Isotonic Exercises

The COI program consist of alternating concentric, eccentric and isometric contractions of agonists against resistance without relaxation^[13] Total duration of 1 repetition is 15 s and of 1 session (including rest intervals) is 15 min. The therapist resists the patient's moving actively through a desired range of motion (concentric contraction).At the end of motion the therapist tells the patient to stay in that position (stabilizing contraction).When stability is attained the therapist tells the patient to allow the part to be moved slowly back to the starting position (eccentric contraction).

Total 3 sets of 15 repetitions at maximal resistance were performed. Rest intervals same as above.

All training sessions had been controlled by the same physical therapist and had a total duration of 30-45 minutes. The

maximal resistance had been provided each time by the physical therapist, intensity progression through 4 week period was carried out according to PNF principles.

Outcome Measures

One Minute Sit up Test: One minute sit up test is one of the most frequently used tests to measure core strength, important in back support and core stability^[4]. This test is having good reliability and validity. (Jabar Haji johari *et al.*, 1993, Maria H. Diener *et al.*, 1995)^[17, 18].

The one minute sit-up test protocol was required the participant to perform as many bent- knee sit-ups as possible in 1 minute. Those subjects who are not able to perform full sit ups in one minute are not included in the study.

Sit up test score: Excellent = >43, Good = 37-43, Above average = 33-36, Average = 29-32, Below average = 25-28, Poor = 18-24, Very poor = <18

Sphygmomanometer

An aneroid sphygmomanometer and a stopwatch were used to obtain the pressure readings. The sphygmomanometer consists of an inflation bulb, air release valve, cuff, bladder hose (or tube) and pressure gauge. The pressure gauge registers changing pressure in an air filled pressure cell allowing body movement, especially spinal movement, detected during exercises. The pressure cell measures from 0-300 mmHg, with a precision of 2 mmHg. Participants was in prone lying, cuff was placed horizontally under the abdomen with the lower edge of cuff just below the anterior superior iliac spine (ASIS) and naval at centre of the cuff. Inflate to 70 mmHg and allowing for detection of fluctuations in pressure that occurs due to normal breathing, which may be approximately 2 mmHg for each inhalation and exhalation. Subjects were instructed to perform drawing-in maneuver. If it done properly, the pressure drops to 6-10 mmHg and subjects was asked to maintain the pressure drop for up to 10 second, measured by a stop watch. A sudden rise in pressure indicates fatigue (Richardson *et al.*, 1999: 114). During this test, the examiner closely monitors the sphygmomanometer gauge and monitors the subject to detect whether any compensatory mechanisms were being employed, included movements of the pelvis and spine, breathe holding and rib elevation. The test was repeated three times and maximum pressure drops only was recorded. 3 minutes rest was given after each test.

Statistical analysis

Statistical Analysis was done by using paired't' and Wilcoxon signed ranks test. SPSS version 20 was used for analysis.

Core strength [Sphygmomanometer] data follow the normality of Gaussian distribution so comparison of pre - post data within groups was done by paired t-test.

One minute sit up test score data did not follow the normality so comparison of pre - post of data within group was done by Wilcoxon signed rank test.

Total 50 subjects selected for study.

Result

The mean age of females was 21.5 + 2.279. The mean BMI of females was 20.784 +2.188 (Table 1). Figure 1 shows age distribution of subjects.

Of the 50 subjects, 3 subjects was dropout (2 subjects having timing problems, 1 subject reported back pain). So total 47 subjects were analyzed.

Table 1: Demographic Data of Participants

Parameters	Mean	SD
Age (Years)	21.5	2.279
Height (feet)	5.291	0.254
Weight (kg)	53.46	7.32
BMI	20.784	2.188

Female n = 50

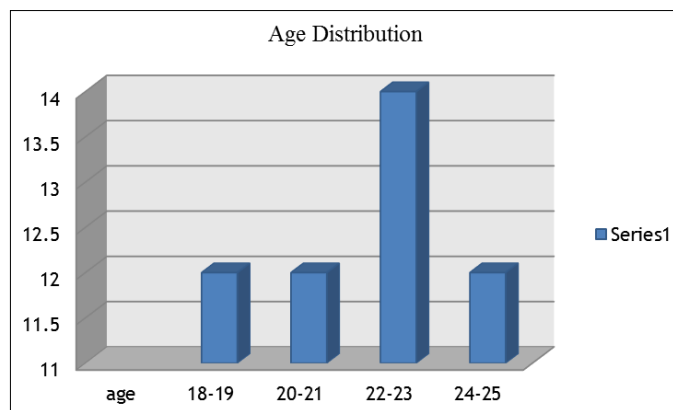


Fig 1

The pre test mean of core strength using sphygmomanometer was 6.47 with the SD of 3.134, when it was compared with the mean of core strength 14.74 after 4 weeks of intervention with the SD of 4.489; the obtained “t” value was 18.153 for a given df of 46 which is statistically significant. This finding had showed that there was a significant difference in core strength using sphygmomanometer in pre-test and post-test (after the 4 weeks treatment) ($p < 0.0001$). (Table 2) (Figure 2).

Table 2: Comparison of Pre and Post Treatment of Core Strength [Sphygmomanometer]

Core strength	Mean	SD	Paired t test	Df	P value
Pre	6.47	3.134	t=18.153	46	<0.0001
Post	14.74	4.489			

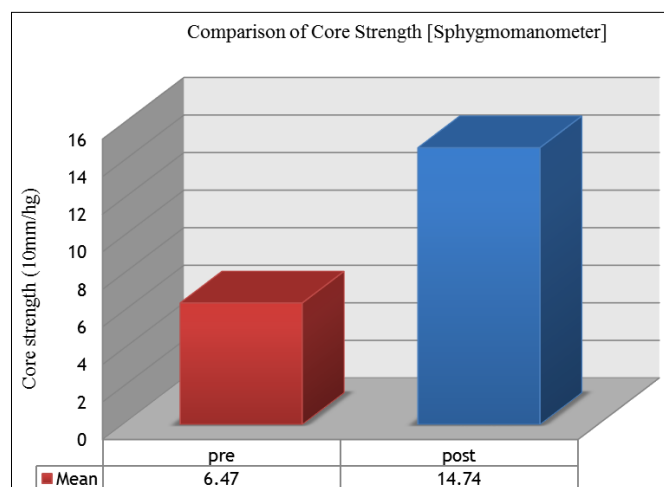


Fig 2

The pre test mean of One minute sit up test was 22.766 with the SD of 4.405, when it was compared with the mean of one minute sit up test 32.489 after 4 week of intervention with the SD of 4.648; the obtained “z” value was -5.981. This finding had showed that there was a significant difference in one

minute sit up test in pre test and post test (after the 4 weeks treatment) ($p = < 0.0001$) (Table 3) (Figure 3).

Table 3: Comparison of Pre and Post Treatment of One Minute Sit Up Test

One minute sit up test	Mean	SD	Wilcoxon test	P- value
Pre	22.766	4.405	Z=-5.981	<0.0001
Post	32.489	4.648		

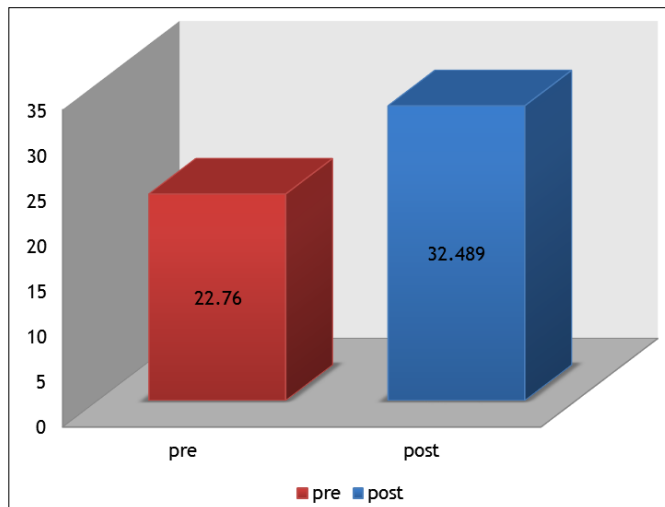


Fig 3: Comparison of One Minute Sit Up Test

Discussion

This study was designed to find out the effect of proprioceptive neuromuscular facilitation exercises on core strength in healthy females.

The finding of the present study shows highly significant improvement in the both outcomes measures – core strength (sphygmomanometer) and one minute sit up test and shows that 4 weeks of PNF exercises significantly increase the core strength in healthy females.

In the present study, both exercise techniques- rhythmic stabilization (RST) and combination of isotonic (COI) exercises involve muscle work at significant intensity levels results in muscle strength improvement. These PNF exercise programs were based on the performance of static and dynamic muscle actions, respectively. The principles of training theory would suggest that muscle adaptations are specific to the type of exercise applied [19].

The results of the present study are in support with other study which concluded that proprioceptive neuromuscular facilitation training improves core strength in patients with type 2 diabetes. Jeba Chitra (2015) showed improvement in core strength with 4 weeks of PNF exercises in patients with type 2 diabetes. He found that the increased core strength may be due to the dynamic nature of combination of isotonic exercise, which uses all muscle action types - eccentric, concentric and isometric through a progressively increased range of motion, and can be related to the static nature of rhythmic stabilization technique [20, 21, 22, 23].

Chandan Kumar *et al.* (2015) studied on Effectiveness of core stability exercise program on abdominal and back strength in school going children and concluded that a well planned core stability exercise program can be helpful to improve the core strength and physical fitness among school going participant over a 12 weeks period of time as compared to normal

physical classes held in school. The results in this study can be based on the Roux's law-soft tissue responds to stress and that remodeling occurs over 6-8 weeks. As they grow, subjects continue to experience weaknesses in the core strength due to lengthening of the musculature as it adapts to postural changes. A maintained level of improvement throughout the training regimen was expected because the exercises were anticipated to offset the weakness that would have developed from the lengthening of the skeletal and musculotendinous units, and the fact that the subjects were undergoing maturation (Gretchen D Oliver *et al.*, 2010) [24].

In adolescents, proper training can enhance strength without muscle hypertrophy. These gains can be attributed to a neurologic mechanism whereby training increases the number of motor neurons that are "recruited" to fire with each muscle contraction. This mechanism accounts for the increase in strength among the population (Kibler WB, 2006) [25].

According to (Alter 1996), proprioceptive neuromuscular facilitation (PNF) is a technique involving combinations of alternating contractions and stretches, whose goal is facilitation of the agonist muscle thereby increase the recruitment of additional motor neurons or increase the excitability of the motor neurons already in use. The facilitation of Agonist leads to inhibition (a decrease in the excitability) of the antagonist (the stretched muscle) resulting in the relaxation of the inhibited muscle and muscular resistance in the facilitated muscle.

N Kofotolis (2017) showed that Proprioceptive neuromuscular facilitation (PNF) training alters fibre type distribution and mean cross sectional area and that these changes occur in the type II fibre subgroup and follow a unidirectional pattern of transformation (fast to slow). Other studies have suggested that strength training induces a histochemical fibre type change that occurs from type IIB to type IIA [16].

Wontae Gon G (2015) showed that Dynamic exercises utilizing PNF patterns can increase thickness of the abdominal muscles, which is a basic requirement for enhancing trunk stability, and they can improve physical functions by stimulating the proprioceptors of muscles and tendons. Nick Kofotolis (2015) studied on Effects of Two 4-Week Proprioceptive Neuromuscular Facilitation Programs on Muscle Endurance, Flexibility, and Functional Performance in Women with Chronic Low Back Pain and concluded that the application of 4-week RST and COI PNF programs increased the muscle endurance of people with CLBP by 23.6% to 81%. In our study, the inclusion of same exercises results in core strength improvement. The exercises were subject specific i.e. the exercise intensity was progressively increased and adjusted to each subject's performance. Thus, significant muscle system adaptations were observed at the end of exercise program.

As one minute sit up test measures the strength of both the core and hip flexor muscles, this sit up test often involve more activity of the hip flexor muscles than of the abdominal muscles [26, 27]. So, when using the sit up to assess core strength, marked weakness of this muscle group is often masked by compensatory actions of the hip flexors and low back [26]. When compared with one minute sit up test, core strength measured using sphygmomanometer has been accepted as an advanced test of core strength because it requires co activation of all the local core muscles to stabilize the pelvis and low back, rather than relying on subsequent

recruitment of the hip flexor muscles to maintain core stability.

The subject participated enthusiastically in the exercise program which promoted the motivation and competition among subject to perform better. Therefore, it would appear that participant 18-25 years of age are an ideal.

Conclusion

The result of the study shows that the application of 4-week Proprioceptive neuromuscular facilitation (PNF) programs has significant effect on core strength in healthy females. These results suggest that short-term programs with dynamic and static PNF exercises are effective in improving core strength in healthy females with age of 18-25 years. This will further help in the prevention of low back pain and incidence of injuries among young females and later in their life.

Further Recommendation of the Study

- Comparative study can be done with other protocol.
- Similar study can be done with more sample size.
- This study can be done in school going children for prevention of low back pain and reduce the risk of injury.
- This` study can also be done in athletic school population to enhance their performance and prevent the sports injuries.
- Lastly a long term follow up can be taken with the same study.

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Conflict of Interest: NIL

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