

EFFECT OF THE PNF DYNAMIC SLOW REVERSAL TECHNIQUE VERSUS TREADMILL TRAINING IN PATIENTS WITH MULTIPLE SCLEROSIS

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Abstract

Objective: Effect of the pnf dynamic slow reversal technique versus treadmill training in patients with multiple sclerosis.

Background Multiple sclerosis (MS) is a chronic disease of the central nervous system in which the body's own immune system attacks the myelin sheath surrounding the axons of neurons in the brain, brain stem and spinal cord. MS is currently the most prevalent disabling neurologic disease of young adults in America. The onset of MS usually occurs between 20 and 50 years of age, with a peak at 30 years. MS is more common in women than men by a ratio 2:1. There is no large scale epidemiological studies from India on the incidence and prevalence of Multiple sclerosis. Based on hospital statistics a prevalence of approximately 1.33/100,000 was reported by Singhal et al in the mid-eighties from the west coast of India.

Study design: Experimental,

Methods: A total of 24 patients meeting the internal and external criteria were taken for the study. Mean values of their age was $38.20 \pm$ years and assigned into two groups, A & B, each group consisting 12 patients.

Results: A total of 24 patients with mild to moderate multiple sclerosis were identified as potential participants for this study and randomly allocated either to the control group (Group A treadmill training) or experimental group (Group B) (Dynamic slow reversal PNF technique for lower limbs). My subjects for study included (15 women and 9 men), with 22 patients of Relapsing remitting multiple sclerosis (RRMS) and 2 patients each with primary and secondary progressive multiple sclerosis respectively. The mean age of patients was $38.20 \pm$ years. Each patient was given either dynamic slow reversal PNF technique alone (Group B) in addition regular physiotherapy program where Group A (Control group) patients were treated with treadmill training in addition regular physiotherapy program. Mean improvements in Fatigue, balance and mobility recorded from baseline (Day 0) to the end of treatment (last day of 4th week/12th session) were all statistically significant.

Conclusion: Proprioceptive neuromuscular facilitation techniques incorporate movement in the three planes of the body. According to the International PNF Association, the PNF approach is considered to be a conceptual approach. Some authors regard it as a method. The differences in considering the terms, concept and method become clear by the description of using components of the PNF approach and the clinical reasoning in making up a treatment strategy. Whether promoting flexibility, developing functional movement, developing muscular strength and endurance, improving joint stability, or increasing neuromuscular coordination and control, PNF technique ie. Dynamic slow reversal, as proven in this study, should be incorporated into the physical therapy setting as a valuable and efficacious component of rehabilitation for patients with multiple sclerosis.

Keywords: PNF technique, treadmill training, multiple sclerosis, rehabilitation.

Introduction

Multiple sclerosis (MS) is a chronic disease of the central nervous system in which the body's own immune system attacks the myelin sheath surrounding the axons of neurons in the brain, brain stem and spinal cord.¹ MS is currently the most prevalent disabling neurologic disease of young adults in America.² The onset of MS usually occurs between 20 and 50 years of age, with a peak at 30 years. MS is more common in women than men by a ratio 2:1.³ There are no large scale epidemiological studies from India on the incidence and prevalence of Multiple sclerosis. Based on hospital statistics a prevalence of approximately 1.33/100,000 was reported by Singhal et al in the mid-eighties from the west coast of India.⁴

Although the exact etiology of the disease is unknown, it is generally accepted that MS involves an abnormal immune response within the central nervous system.⁵ The variable distribution of demyelination and axonal loss throughout the central nervous system may lead to disorders of strength, sensation, co-ordination and balance, as well as visual, cognitive and affective deficits, that may lead to severe progressive limitations of functioning in daily life⁵. Common symptoms of MS include decreased walking ability and balance, as well as increased muscle weakness and fatigue. These symptoms and several others are not only detrimental to general health, but the ability to perform routine life activities, such as those mentioned above, and many other everyday motor movements.²

Mobility impairment is also a major consequence of MS. Declines in functional mobility are associated with loss of social connection, reduced participation and altered abilities to perform self-care, productivity and leisure occupations.⁶ MS patients also experience muscle weakness as a major obstacle, contributing to poor balance, risk of falls, and limiting activities of daily living. Few past reviews concluded that physical therapy provides clear muscle strengthening benefits for people with MS regardless of the type of exercise used in treatment.¹

One of the most common MS symptoms is generalized fatigue unrelated to physical exertion:

40% of patients in one study described fatigue as their single most disabling symptom. Several studies, including the widely-cited Petajan et al study, demonstrated that regular physical activity may alleviate MS-related fatigue while enhancing functional reserve capacity.¹ The Fatigue Management Panel of the Multiple Sclerosis Council for Clinical Practice Guidelines defines fatigue as "a subjective lack of physical or mental energy that is perceived by the individual or caregiver to interfere with usual and desired activities."⁷ Fatigue among MS individual defined as "a sense of physical tiredness and lack of energy, distinct from sadness and weakness".⁸ Up to 92% of the patients complains of fatigue and is one of the most common and troubling problems.⁹ Over 80% who have fatigue report that it is exacerbated by heat, which appears to be different between MS fatigue and fatigue due to other chronic diseases.⁸

Approximately 75% of people with MS report problems with balance at some stage during the course of their disease. Functionality is influenced to varying degrees by balance impairments, since balance requirements are dependent on functional tasks. Furthermore, since MS can affect any area of the CNS, a number of systems may contribute to loss of balance control. The more systems damaged, resulting in balance dysfunction, the more difficult compensation will become.¹⁰ Managing balance problem in people with MS is complicated by the variability of lesion affecting multiple neurologic processes.¹¹

Although breakthroughs in pharmaceutical interventions have proven effective in modifying disease severity, there is still no known cause or cure for MS. However, current studies suggest that individualized exercise treatment can promote important therapeutic outcomes in managing MS symptoms.¹ In the last decade the number, as well as the quality of published scientific studies and systematic reviews in MS rehabilitation have clearly increased.¹²

The large heterogeneity of the disease requires comprehensive management by a multidisciplinary rehabilitation team. Different types of interventions are recommended at

different stages of the disease. Physiotherapy is commonly recommended, and tentative evidence suggests that it may be helpful to improve physical functioning or prevent deterioration. There is, however, limited evidence to guide the therapist in choosing the most effective approach.¹³

Treadmill training is a 'task orientated' method of gait training that is highly repetitive and promotes a specific practice of walking. There is an increasing recognition that regular participation in aerobic exercise may benefit people with MS. Treadmill training is used to increase aerobic fitness, on walking performance and levels of fatigue in people with MS. Previous studies have shown that treadmill training in MS individuals is feasible, well tolerated and increases gait speed and endurance, and importantly does not worsen symptoms of fatigue.⁷⁰

Proprioceptive neuromuscular facilitation (PNF) exercise enhance the response of neuromuscular mechanism by stimulating the proprioceptors.¹⁴ The patterns of PNF exercises have a spiral, diagonal direction, and the performance of these pattern is in line with the topographic arrangement of the muscle being used.^{14, 15} As a treatment philosophy, PNF is derived from the idea that all human beings, including those with disabilities, have untapped existing potentials.¹⁶ These exercises are very similar to the actions and movements found in various activities of daily life. The performance of movements in PNF patterns may permit muscles to act in ways that are close to the action and movements found in various sports.¹⁷ Therefore these exercise may be better suited for performance enhancement than the conventional single-plane or single-direction weight-training or resistant or resistance programs.¹⁴

PNF is widely used in physical therapy as a rehabilitation method especially in patients with cerebral palsy and multiple sclerosis but also used in rehabilitation of orthopedic problems, arthritis and peripheral nerve injuries.¹⁸ Furthermore, PNF techniques often have been used to improve the range of motion of a joint and endurance as well as performance in a vertical jump. A variety of methods fall under the rubric of PNF, including the exploitation of postural reflexes, use of gravity to facilitate movement in weak muscles, the use of

eccentric contractions to facilitate agonist muscle activity and the use of diagonal movement patterns to facilitate the activation of bi-articular muscles.^{16,19}

A study done by Broach and Dattilo (2001) have found increases in performance for individuals with MS while walking up and down stairs, rotations on a stationary bike and an upper extremity ergo meter.²⁰

Reversal of antagonists is a general class of techniques in which the patient first contracts the agonistic muscle then contracts their antagonists without pause or relaxation. Within that class Dynamic reversal of antagonist is an isotonic technique where the patient first move in one direction and then in the opposite direction without stopping.¹⁷

There is a paucity of data about the application of PNF techniques in patients with multiple sclerosis and there are limited studies examining the effect of PNF exercises in multiple sclerosis.

Because limited research related to the effects of PNF exercises on mobility, balance and muscular fatigue has been found, this study was designed to study the efficacy of dynamic slow reversal technique in patients with multiple sclerosis.

Aims and Objectives

To study the effect of the Proprioceptive Neuromuscular facilitation (PNF)'s dynamic slow reversal given along with the patterns D1 & D2 of lower limbs on improving balance, mobility and reducing fatigue in patients with multiple sclerosis.

To study the effects of treadmill training on improving balance, mobility and reducing fatigue in patients with multiple sclerosis.

Hypothesis

Experimental Hypothesis

The PNF dynamic slow reversal technique will be either more effective or equal to treadmill training in improving mobility, balance and reducing fatigue in patients with multiple sclerosis.

Null Hypothesis

The PNF dynamic slow reversal technique will be less effective than Treadmill training in improving

mobility, balance and reducing fatigue in patients with multiple sclerosis.

Statement of the Question

- Will the PNF dynamic slow reversal technique enhance patient outcomes on improving mobility, balance and reducing fatigue in patients with multiple sclerosis in addition to their regular physiotherapy?
- Will the Treadmill training enhance patient outcomes on improving mobility, balance and reducing fatigue in patients with multiple sclerosis in addition to their regular physiotherapy?
- Will the PNF dynamic slow reversal technique in addition to regular physiotherapy be more effective or equal to or less effective than Treadmill training in addition to regular physiotherapy in improving mobility, balance and reducing fatigue in patients with multiple sclerosis.

Operational Definitions

Proprioceptive neuromuscular facilitation (PNF)

Proprioceptive neuromuscular facilitation (PNF) may be defined as "promoting or hastening the neuromuscular mechanism through stimulation of proprioceptors". Developed in the 1940s by Kabat, Knott and Voss, PNF is an integrated approach treatment directed at a total human being not at a specific problem or body segment.¹⁷

Dynamic slow reversal

This technique involves a dynamic concentric contraction of the stronger agonist muscle group. A second dynamic concentric contraction immediately follows, this time involving the weaker antagonist muscle group. Rest periods do not occur between contractions. Therefore, this technique promotes the rapid, reciprocal activities the agonist and antagonist muscle groups need for many functional activities.²¹

Fatigue

The Fatigue Management Panel of the Multiple Sclerosis Council for Clinical Practice Guidelines defines fatigue as "a subjective lack of physical or mental energy that is perceived by the individual or caregiver to interfere with usual and desired

activities. Fatigue among MS individual defined as "a sense of physical tiredness and lack of energy, distinct from sadness and weakness". Peripheral factors as well as central factors may be involved in the pathogenesis. Up to 92% of the patients complains of fatigue and is one of the most common and troubling problems.

Balance

Balance requirements are dependent on functional tasks. Furthermore, since MS can affect any area of the CNS, a number of systems may contribute to loss of balance control. The more systems damaged, resulting in balance dysfunction, the more difficult compensation will become.¹⁰

Methodology

Sample

A total of 24 patients meeting the internal and external criteria were taken for the study. Mean values of their age was $38.20 \pm$ years. And assigned into two groups, A & B, each group consisting 12 patients.

Study design

1. Experimental study

Inclusion Criteria

- Diagnosis of clinically or laboratory supported MS
- MS patients with mild to moderate disability (Expanded Disability Status Scale scores 1.0 to 5.5)
- Ambulatory MS Patients
- Stable disease process within last 6 weeks
- No clinical relapse for at least one month prior to study entry
- Age between 25 and 55 years
- No concomitant therapy with anti-depressant, psychoactive or steroid drug, as well as with other drug that are used for the treatment of fatigue (eg.amantadine)
- No surgeries in past 6 months

Exclusion criteria

- Patients with current relapse of multiple sclerosis
- Any major surgeries in the past 6 months
- pregnancy

- History of cardiovascular, respiratory, orthopedics or metabolic disease as diagnosed by physician.
- Any disease preventing participation in the prescribed exercise program
- Any mental illness as diagnosed by physician

Instrumentation and outcome measures

- Treatment Couch
- Stop watch
- Arm rest chair
- Inch tape
- Chalk piece
- Pillows
- Motorized treadmill
- Borg's Perceived Exertion Scale
- Kurtzke Expanded Disability Status Scale (EDSS)
- Outcome measures
 - Time up and go test scale.
 - Berg balance scale.
 - Modified fatigue impact scale.

Description of scale

Time-up & go test (TUG)

The timed "Up and Go" test measures, in seconds, the time taken by an individual to stand up from a standard arm chair (approximate seat height of 46 cm, arm height 65 cm, walk a distance of 3 meters, turn, walk back to the chair, and sit down.^{23,24}

Validity and reliability

The Timed "up and go" test showed good intrarater and interrater reliability ($r = .93$ and $.96$, respectively). Adequate concurrent validity.⁷⁴

Modified Fatigue impact scale (MFIS)

The MFIS is a structured self-report questionnaire. The subscales are how fatigue relates to physical,

cognitive and psychosocial aspects of functioning. This version has a Cronbachs alpha of $.81$ indicating good reliability. A recent review of the literature suggested that the MFIS may have greater sensitivity to change than the Fatigue Severity Score. Administration time is approximately 5 to 10 minutes.^{25, 26, 27}

Validity and reliability

This version has a Cronbachs alpha of $.81$ indicating good reliability. It is showing criterion-related validity.^{25, 26, 27, 68}

Berg Balance scale (BBS)

The BBS is a clinical scale that evaluates balance in sitting and standing and rates performance from 0 (cannot perform) to 4 (normal performance). The scale has fifteen items that explore the ability to sit, stand, lean, turn and maintain the upright position on one leg. The BBS has been validated for use in people with multiple Sclerosis. It was found to have good concurrent validity and a cut off score of 44 (out of 56) was established as a criterion to identify PwMS who have a high risk of falls. The reliability of the BBS has also been examined in PwMS. It was found to have high test retest and interrater reliability, both having intraclass correlation coefficients (ICCs) of 0.96 . The BBS is widely used by physiotherapists and takes approximately 15 minutes to complete.²⁵

Validity and reliability

It shows high test retest and interrater reliability, both having intraclass correlation coefficients (ICCs) of 0.96 and good concurrent validity.²⁵



Figure 3.1: Arm rest chair



Figure 3.2 Stop watch.

Protocol

Both groups received regular physiotherapy treatment throughout the study period other than Dynamic slow reversal PNF technique and treadmill training.

Group B (Experimental group) were treated with Dynamic slow reversal PNF technique in addition to regular physiotherapy program which they were undergoing on regular basis whereas Group A (Control group) patients were treated with treadmill training in addition to regular physiotherapy program which they were undergoing on regular basis. Treadmill training consisted of supervised aerobic exercise delivered three sessions each week for 4 weeks. Patients were provided rest period immediately after the treadmill training. Each treatment session per day lasted for about 45 minutes for PNF and 30 minutes for treadmill training, which included 5 minutes warm up and 5 minutes cool down period with a total of 12 treatment sessions (three times a week for 4 weeks). APMHR were calculated by following formula. Calculate predicted maximum heart rate (MHR) by subtracting age from 220

The subject was allowed to stop the treadmill training in between if he/she felt fatigued.⁷⁰

The measurement of both the groups was done at baseline and at 4 weeks after the study period finished.⁷⁰

Procedure

A total of 24 subjects who were previously diagnosed as case of multiple sclerosis by a neurologist and met the inclusion criteria were included in the study prior to enrolling in to the study, met and purpose of the study were told to the participants. Informed consent was signed before study.

Group B (Experimental group)⁶²

The treatment in this group consisted of dynamic slow reversal PNF technique applied to the lower extremities. The subject remained in relaxed, comfortable and supine position on the bed with the feet uncrossed. Therapist stands on either side of the lower limb of the subjects. At the start, the muscles of the dominant lower extremity were placed in the longest position.⁶²

This technique involved a dynamic concentric contraction of the stronger agonist muscle group. A second dynamic concentric contraction immediately followed, this time involving the weaker antagonist muscle group.²¹ The elements of PNF, such as manual contact, stretch, resistance, and verbal cuing, were incorporated into the treatment scheme. The efforts of the patient and myself were well synchronized.

The lower extremity has two diagonals (D1 and D2) named after the hip motion. Hip abduction is the leg movement from middle to the side and adduction means the contrary movement, toward the middle. At internal rotation of the hip, knee point to middle and in external rotation to the side. In each pattern of exercise the three distinct movements were combined similar to the functional human movements. The movement series was performed according to the principles of PNF in a distal to proximal direction.¹⁸ The motion started with an initial stretch reflex and followed the movement of the subject's limb, so a continuous resistance was being given.⁶² Two minutes of rest period was given after each exercise pattern was practiced for 5 times.

D1 flexion and D1 Extension:

Starting with the antagonist pattern Hip was placed into extension abduction and internal rotation, the knee into extension; planter flexion and eversion of the ankle; and toes flexion.⁶³

- Agonist patterns of flexion, adduction, and external rotation, and an antagonist pattern of extension, abduction, and internal rotation were used.⁶²

D2 flexion and D2 Extension:

- Agonist patterns of flexion, abduction, and internal rotation, and an antagonist pattern of extension, adduction, and external rotation were used.²¹

Description¹⁷

- Subject was lying on the supine position
- Therapist stands on either side of the lower limb of the subjects.
- Myself resisted the patient's movement in one direction, usually the stronger or the better direction.

- As the end of desired range of motion approached, I reversed the grip on the distal portion of the moving segment and gave a command to prepare the change of direction.
- At the end of desired movement I gave the action command to reverse direction, without relaxation and gave resistance to knee motion starting at the distal part.
- When the patient began moving in the opposite direction, I reversed the proximal grip, so that resistance opposed the new direction.
- The reversal may be done as often as necessary.¹⁷

Group A (Control group)⁷⁰

Therapist stood on the side of the treadmill.

Individuals received supervised treadmill training, three sessions each week, for 4 weeks. Walking duration was increased during the training period as tolerated by participants, up to a maximum of 30 minutes. Depending on the individuals performance and tolerance rest were incorporated during the treadmill training session. Once maximum walking duration was attained, intensity was increased by increasing walking speed. Individuals were encouraged to train at an intensity of 55–85% of age predicted maximum heart rate (APMHR) according to American College of Sports Medicine guidelines.⁷⁰

Initially 55-60% APMHR was set to perform which was considered moderate intensity in treadmill training. After conditioning period was over vigorous intensity was set between 60-85% to be performed by participants.⁶⁹

Subjects on motorized treadmill were trained with unrestricted garment, light weighted shoes and supported by handrail of the treadmill. Treadmill training was given initially with short bouts of low intensity treadmill for 5 minutes followed by 20 minutes of continuous as tolerated treadmill training of intensity 55-85% of age predicted maximum heart rate (APMHR) by heart rate monitor.^{69,70}

Blood pressure, heart rate and perceived exertion (CR10-RPE) were monitored manually pre and post training session. If blood pressure rose to

>200 mm Hg systolic or >110 mm Hg diastolic or HR rose to >160/min, training was discontinued.⁶⁹ After 20 minutes period 5 minutes of cool down period with short bouts was given which included low intensity of treadmill. Patients were encouraged to train at intensity of 55-85% of age predicted heart rate (APMHR). Speed was increased according to the patient's tolerance. Fan and water were available to counter the effects of heat. The intensity of exercise was reduced if aggravating symptoms arose during treadmill training session. Exercise was stopped immediately if unusual symptoms were experienced (e.g. dizziness, nausea, or chest pain) by the subjects.^{69, 70}

After 4 weeks the post intervention data was collected.

Results

A total of 24 patients with mild to moderate multiple sclerosis were identified as potential participants for this study and randomly allocated either to the control group (Group A treadmill training) or experimental group (Group B) (Dynamic slow reversal PNF technique for lower limbs). My subjects for study included (15 women and 9 men), with 22 patients of Relapsing remitting multiple sclerosis (RRMS) and 2 patients each with primary and secondary progressive multiple sclerosis respectively. The mean age of patients was 38.20± years. Each patient was given either dynamic slow reversal PNF technique alone (Group B) in addition regular physiotherapy program where Group A (Control group) patients were treated with treadmill training in addition regular physiotherapy program. Mean improvements in Fatigue, balance and mobility recorded from baseline (Day 0) to the end of treatment (last day of 4th week/12th session) were all statistically significant. Due to the nature of the outcome measures parametric statistical tests were used. Intra group analysis for balance, fatigue and mobility was done using paired t test and inter group analysis was done using independent t-test. The data was analyzed using SPSS software version 16.

Table 5.1: Distribution of Age, and EDSS score

Demographic	Group A		Group B	
	Mean	SD	Mean	SD
Age(In Years)	39.08	9.649541	38.16667	7.432525
EDSS	3.583333	1.083625	3.666667	1.007547

Table 5.1: Shows that Age, EDSS and onset bias is eliminated and samples are matched between the two Group-A and Group-B respectively.

Intra Group Analysis

Intra group analysis was done using paired t-test. The results of this group analysis of Time up and Go (TUG) test, Modified fatigue impact scale, Berg balance score showed that

there was a significant difference in mobility, balance and fatigue both clinically and statistically with group A (p value = 0.005) and group B (p = 0.005) which means that there was significant improvement of mobility, balance and fatigue in both the groups.

Table 5.2: Comparison of mean and SD of TUG- Pre, TUG- Post For Group A and Group B

TUG	Group A		Group B	
	Mean	SD	Mean	SD
TUG – Pre	32.58	5.79	31.16	7.83
TUG – Post	28.75	6.23	20.58	6.70

Table 5.2: shows comparison of mean and standard deviation of pre and post TUG SCORE of Group-A and comparison of mean and standard deviation of pre and post TUG scores of Group-B.

Table 5.3: Comparison of mean values of TUG- pre, TUG- post within Group A and Group B

	Group A		Group B	
	T – Value	P- value	T - value	P – value
TUG	5.800	0.000<0.05	11.871	0.000<0.05

Table 5.3: Shows that T - values and P- values for TUG- Pre, TUG- Post for Group A are 5.800 and 0.05 and the T- values and p- values for TUG-Pre, TUG- Post for Group B are 11.871 and 0.05. It shows that the treatment given to both the groups are effective.

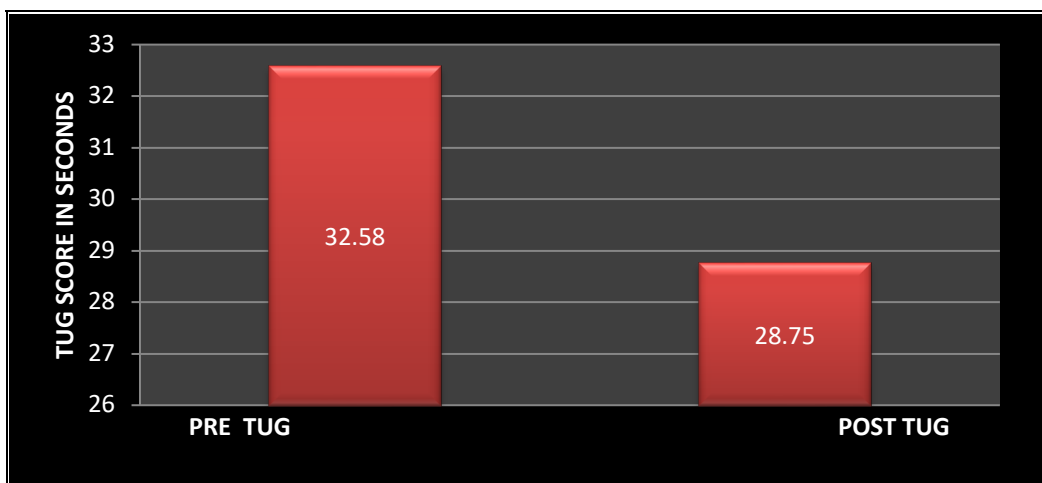
**Figure 5. 1:Intragroup Comparison of TUG Pre and Post of Group A**

Figure 5. 1: Depicts improvement in mean difference of post TUG scores of Group A compare to pre TUG score of Group A.

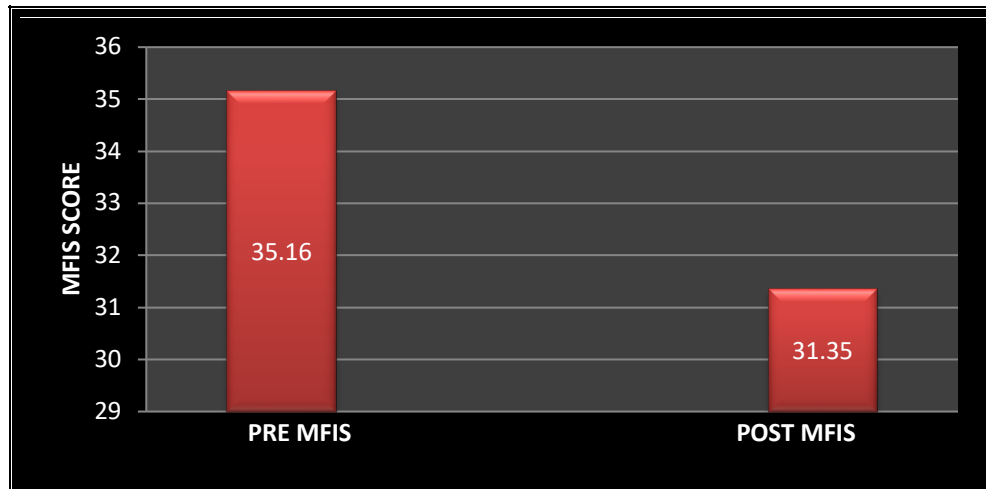


Figure 5. 2: **Figure 5. 2: Intra group comparison of pre and post MFIS of Group-A**

Depicts improvement in mean difference of post MFIS scores of Group A compare to pre MFIS score of Group A.

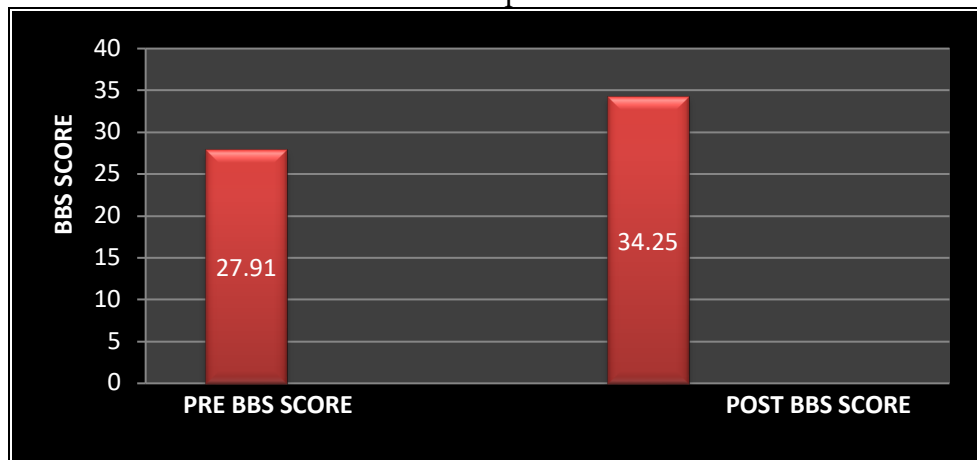


Figure 5. 3: **Intra group comparison of pre and post BBS score of Group-A**

Figure 5. 3: Depicts improvement in mean difference of post BBS scores of group A compare to pre BBS score of group A

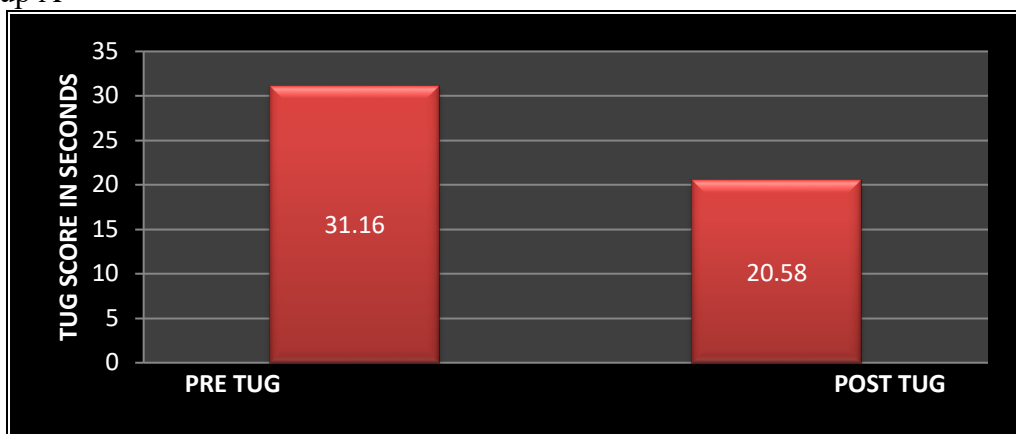


Figure 5. 4: **Intra group comparison of pre and post TUG of Group-B**

Figure 5. 4: Depicts improvement in mean difference of post TUG scores of group B compare to pre TUG score of group B.

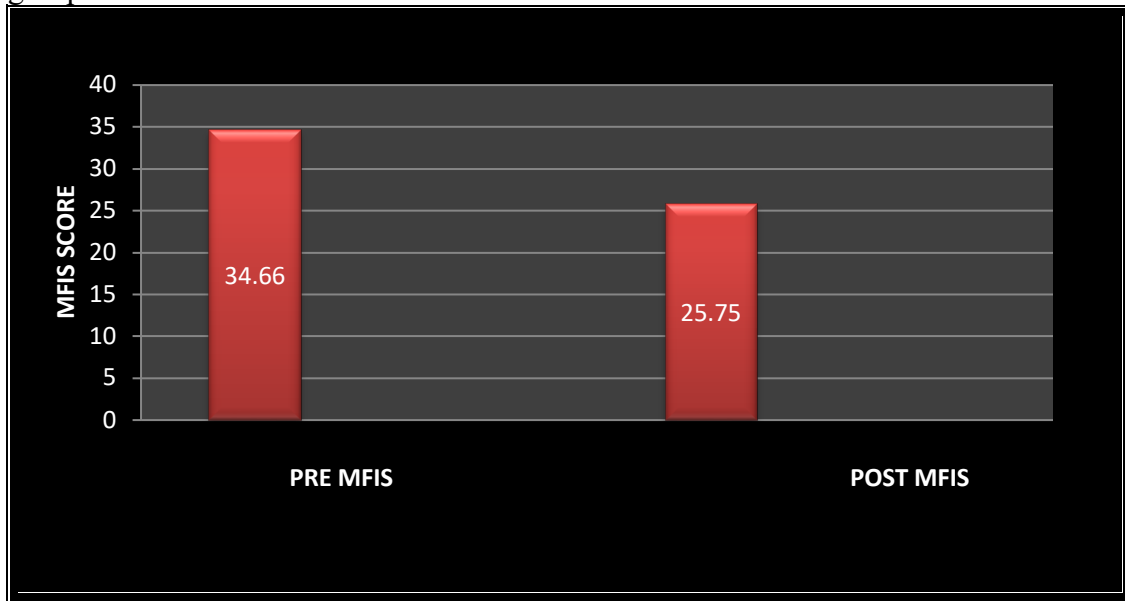


Figure 5.5: Intra group comparison of pre and post MFIS of Group-B

Figure 5.5 Depict improvement in mean difference of post MFIS scores of group B compare to pre MFIS score of group B.

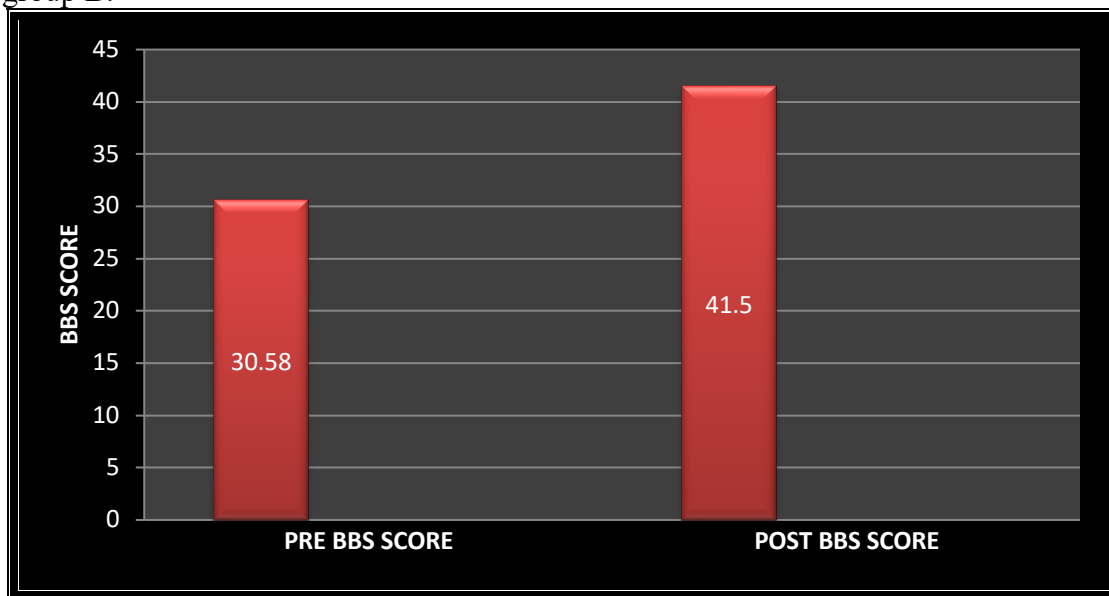


Figure 5.6: Intra group comparison of pre and post BBS score of Group-B

Figure 5. 6: Depict improvement in mean difference of post BBS scores of Group B compare to pre BBS score of Group B.

Table 5.4: Comparison of mean and SD of MFIS- pre, MFIS- post for Group A and Group B

MFIS	Group A		Group B	
	Mean	SD	Mean	SD
MFIS - Pre	35.16	5.93	34.66	4.77
MFIS - Post	31.25	5.46	25.75	5.46

Table 5.5: Comparison of mean values of MFIS- pre, MFIS- post within Group A and Group B

	Group A		Group B	
	T - Value	P- value	T - value	P - value
MFIS	5.421	0.000<0.05	13.575	0.000<0.05

Table 5.5: shows that T - values and p- values for MFIS- Pre, MFIS- Post for Group A are 5.421 and 0.05 and the T- values and p- values for MFIS-Pre, MFIS- Post for Group B are 13.575 and 0.05. It shows that the treatment given to both the groups are effective.

Table 5.6: Comparison of mean and SD of BBS- pre, BBS- post for Group A and Group B

BBS	Group A		Group B	
	Mean	SD	Mean	SD
BBS – Pre	27.91	4.33	30.58	4.79
BBS- Post	34.25	3.93	41.50	5.00

Table 5.7: Comparison of mean values of BBS- pre, BBS- post within Group A and Group B

	Group A		Group B	
	T - Value	P- value	T - value	P - value
BBS	22.279	0.000<0.05	22.557	0.000<0.05

Table 5.7: shows that T - values and p- values for BBS- Pre, BBS- Post for Group A are 22.279 and 0.05 and the T- values and p- values for BBS-Pre, BBS- Post for Group B are 22.557 and 0.05. It shows that the treatment given to both the groups are effective.

Inter Group Analysis

independent t-test was used for between group analysis and the following results were obtained. During inter group analysis post BBS, MFIS and TUG scores were found to be clinically

as well as statistically significant in group A compared to group B. Also there was no significant difference in pre and post BBS, MFIS and TUG scores as shown in table 5.6, 5.4 and 5.2 and figure 5.9, 5.8, and 5.7.

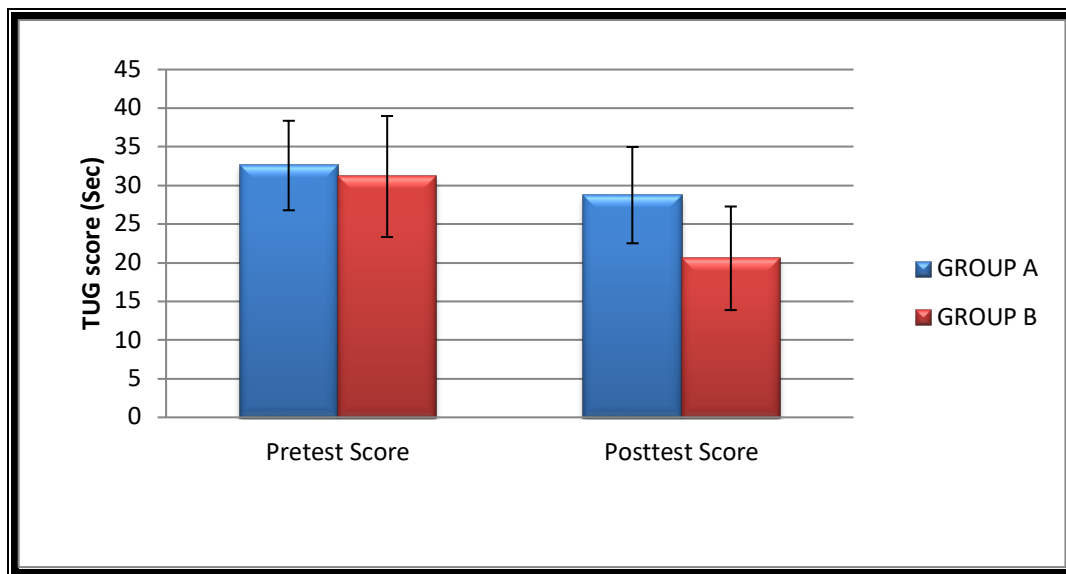


Figure 5.7: Inter group comparison of pre and post TUG score between Group-A and Group-B

Figure 5.7: Depicts improvement in mean difference of pre TUG score of subjects of Group-B as compared to subjects of Group-A

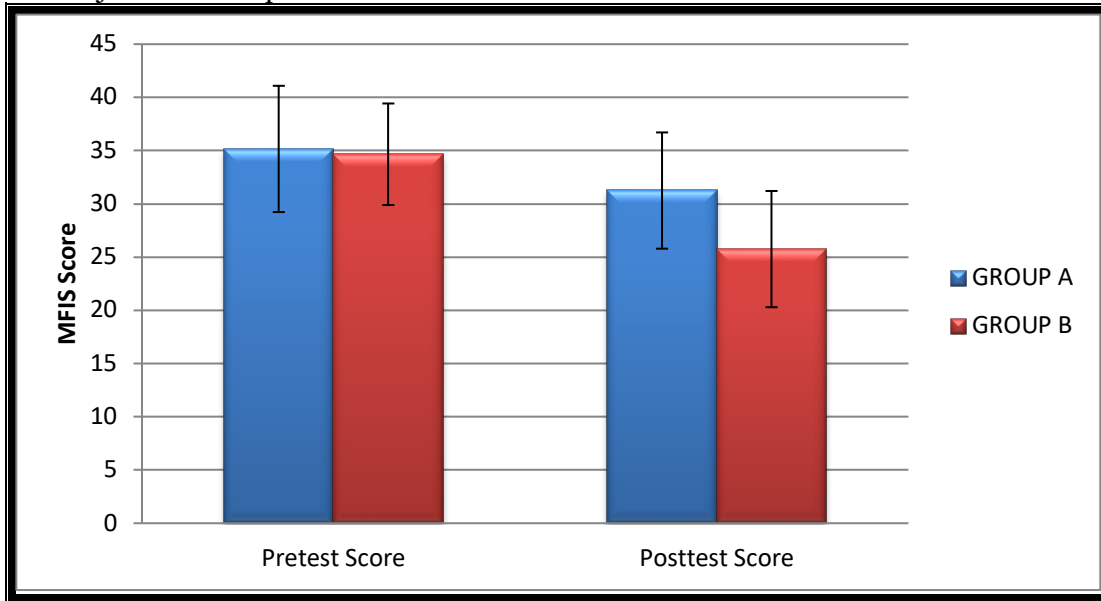


Figure 5. 8: Inter group comparison of pre and post MFIS score between Group-A and Group-B

Figure 5.8: Depicts improvement in mean difference of pre MFIS score of subjects of Group-B as compared to subjects of Group-A

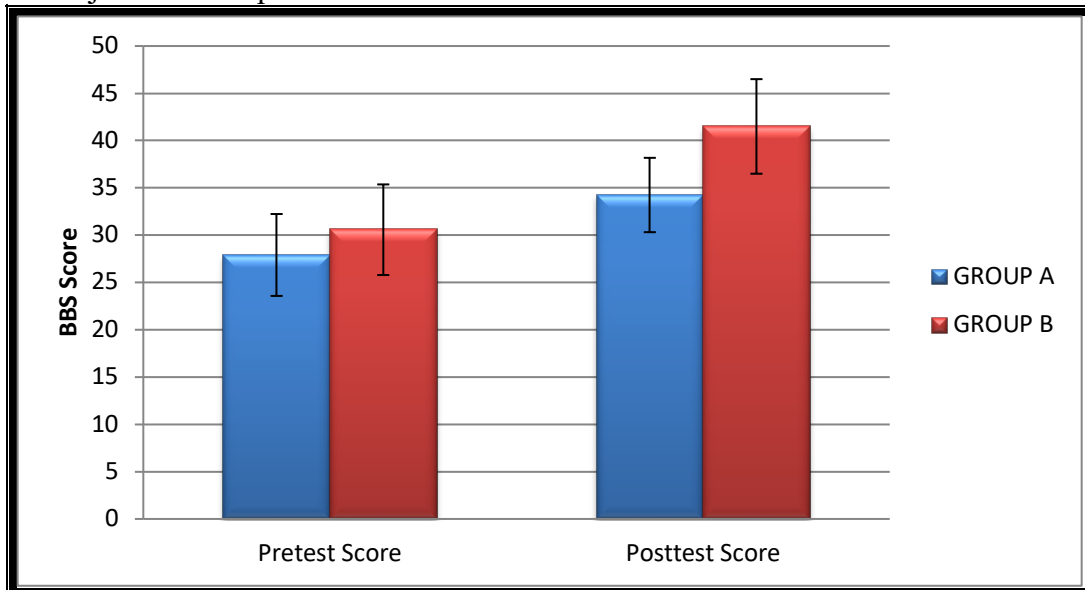


Figure 5. 9: Inter group comparison of pre and post BBS score between Group-A and Group-B

Figure 5.9: Depicts improvement in mean difference of pre MFIS score of subjects of Group-B as compared to subjects of Group-A

- ❖ From above Figure and tables we can say that treatment were effective for both group.
- ❖ From above Figure and tables we can say/infer that Group B showed significant improvement as compared to Group- A in TUG, MFIS and BBS.
- ❖ For TUG, Group-B showed significant improvement at post intervention compared to Group-A.
- ❖ For MFIS, Group-B showed not significant improvement at post intervention compared to Group-A.

- ❖ For BBS, Group-B showed highly significant improvement at post intervention compared to Group-A.
- ❖ From these results we conclude that the Group-B is better than Group-A.

Discussion

Physiotherapy in MS has become an essential approach in the recent years because of functional, psychological, and physical limitation of MS. Numerous studies have investigated disability and quality of life in MS. Most of the studies in the literature are interested in the effect of rehabilitation on strength, spasticity, and gait disorder. However, all the problems stated require different specific approaches⁵⁹. Patients with MS have a normal life expectancy, therefore, they may have to live for many years with severe mobility problems and have a need for regular therapeutic intervention.²⁵

In the PNF approach, there is a large emphasis on effective motor learning strategies such as practice, repetition, visual guidance of movement, and so forth.¹⁷ Today, current literature trend indicates a “dynamic systems approach” may bring about more beneficial and rapid changes in development. This dynamic systems approach involves the simultaneous stimulation of multiple systems, including the physical, sensory, cognitive, and motivational system.⁶¹ This “whole” approach seems to have a greater impact on the learning of new skills. PNF has always placed demand on patients in order to achieve change and therefore easily fits into the classification of “dynamic systems approach”.⁶¹ Studies also show that when patients receive multiple inputs and a greater demand is placed upon them, they show greater potential for improvement in a shorter period of time.⁶¹

Goal directed activity is made up of reversing movements. Early motor behavior occurs in random fashion through full range of motion. The spontaneous limb movements of the new born usually fluctuate from extremes of flexion to extension. These movements are rhythmic and reversing continuing through the life⁶⁴ for example the act of eating is a reversing movement of the arm and jaw. If a patient cannot reverse directions, his functional ability will be limited. So

rhythmic reversing of direction (Dynamic slow reversal) was used as a goal of treatment in this study to reestablish the balance and interaction between antagonists. The aim was to increase the proprioceptive input by mechanically stimulating the joint surfaces, muscles and tendons, and decreasing postural instability by improving body awareness³⁶.

The basis of “reversal of antagonists” idea is intriguing and quite simple: an isometrically contracting flexor muscles (e.g., of the elbow) will help develop extensor strength in the antagonist muscles. In other words, an isometric flexion immediately before an extensor contraction facilitates extensor function through some sort of conditioning mechanism. The mechanism of this process is believed to be rooted in flexor Golgi tendon organ feedback produced during the “conditioning” flexor contraction, which is known to lower the firing threshold of extensor alpha motoneuron. This proprioceptive feedback then is thought to combine with centrally generated commands to activate more motor units than would normally be recruited⁶⁵.

Normal movement and posture depend on "synergism" and a balanced interaction of antagonists. This principle encompasses that the early motor behavior is dominated by reflex activity; mature motor behavior is reinforced or supported by postural reflex mechanisms and goal-directed activity. The growth of motor behavior has cyclic trends as evidenced by shifts between flexor and extensor dominance. It states the main goal in the PNF approach: to develop a balance of antagonists. A continual adjustment in reflex activity, dominance, and reversing or antagonistic movements is required for the constant changes of movement and posture that occur in functional activity. For example, getting dressed demands interaction in all of these areas. Without a balance of antagonists, the quality of performance decreases, becoming more deliberate and losing its smooth and rhythmical characteristics. Thus in treatment, prevention and correction of imbalances between antagonists are objectives.⁶⁴

In this Experimental study Experimental group showed improvements in the post test parameter of TUG, MFIS, BBS, as compared to the pre test parameters, as shown in table 2 and figure 4 the

mean post-TUG scores was 20.58 ($p < 0.05$) and mean pre-TUG score 31.16 ($p < 0.05$). In Table 4 and figure 5 the mean post- MFIS scores was 25.75 ($p < 0.05$) and pre-MFIS score 34.66 ($p < 0.05$). In Table 6 and figure 6 the mean post- BBS scores was 41.50 ($p < 0.05$) and pre -BBS score 30.58 ($p < 0.05$).

These results can be due to the fact that the amount of sensory input coming from the periphery was greater in the PNF. Which might have induced changes in the excitability of the pyramidal tract, the final motor pathway. Therefore, one can only speculate about the causes of the advantage of the PNF patterns.¹⁹

One possibility, is that the PNF patterns which produce sensory inputs from the periphery lead to stronger excitation of the cortical area, causing variations in the thresholds of a number of motoneuron.¹⁹

Manual resistance strengthening, PNF diagonal patterns enhance proper sequencing of muscular contraction, from distal to proximal. This promotes neuromuscular control and coordination to enhance coordination, movement and stability.²¹ Dynamic slow reversal technique promotes the rapid, reciprocal activities the agonist and antagonist muscle groups need for many functional activities.²¹

Application of the PNF patterns is supposed to facilitate patient's and therapist's efforts towards the re-education of the lost motor function via a temporary reduction in spasticity. Expectations associated with the combination of these therapies include mainly the possibility to maintain and consolidate the effect of rehabilitation involving reproduction of normal motion patterns, reduction of pathological movements induced by spasticity of the paretic limbs, and an improvement in patients' quality of life by reducing disturbances of functioning.⁵⁴

Previous research which has revealed both excitatory and inhibitory effects on neurons and muscles in response to PNF. Excitatory effects include (1) post contraction sensory discharge (from muscle spindles); (2) post-tetanic twitch (force) potentiation; (3) post-tetanic potentiation of monosynaptic reflexes and of motor end-plate potentials; and (4) post contraction facilitation of

stretch, tendon tap, and vibration reflexes. Inhibitory effects were described as a component of successive induction. They observed that, following reflex activation of an agonist, a reversal process sometimes occurred, involving antagonist facilitation and reciprocal inhibition of the agonist. This process is called "successive induction"⁶⁶.

The results of this study are consistent and similar to a structured program done in 2003 which included PNF training with manual resistance. It was proven effective for sub acute stroke patients with gain in endurance, balance and mobility beyond that of natural recovery⁵³.

The typical contribution of PNF to improve coordinative skills in this study could be attributed to the multiple stimulation as explained by Mulder "Changes in the somato-sensory input leads to changes in activity of cortical regions involved in motor control and by this to changes in motor output"⁶⁷

In a previous study patients with ataxia were treated with 4 weeks of proprioceptive neuromuscular facilitation (PNF) combined with Frenkel coordination exercise in supine, sitting, and standing position. Half of the patients also wore long-leg splint for 20 minutes before exercise. For both groups, significant improvements were found in anterior balance, single-limb stance time, walking speed, and ambulation index.^{36, 59}

This study is also supported by study done by Broach and Dattilo (2001) who found increases in performance for individuals with MS while walking up and down stairs, rotations on a stationary bike and an upper extremity ergo meter. Two of the activities that were performed during this study included PNF patterns and aquatic stepping. PNF patterns are useful as they gear to improve coordination and ability to perform a movement²¹

In the present study Control group showed improvements in the post test parameter of TUG, MFIS, BBS, as compared to the pretest parameters, as shown in table 2 and figure 1 the mean post-TUG scores was 28.75 ($p < 0.05$) and mean pre-TUG score 32.58 ($p < 0.05$). In Table 4 and Figure 2 the mean post- MFIS scores was 31.25 ($p < 0.05$) and pre-MFIS score 35.16

($p < 0.05$). In Table 6 and figure 3 the mean post-BBS scores was 34.25 ($p < 0.05$) and pre -BBS score 27.91 ($p < 0.05$).

Treadmill training represents a “task-oriented” exercise for gait training, effective both at enhancing walking ability and fighting cardiovascular de-conditioning.⁷²

The cardiovascular and pulmonary systems respond to an acute bout of aerobic exercise by augmenting oxygen delivery to active skeletal muscle in an attempt to meet the energy requirements for a given level of physical stress. The capacity to increase oxygen delivery and utilization in response to aerobic exercise is dependent on several factors. Furthermore, regular participation in aerobic exercise over a prolonged period of time results in numerous positive adaptations to the physiologic systems involved. As a result, the ability of these physiologic systems to deliver and use the oxygen needed for aerobic activity is enhanced.⁷⁴

It has been suggested that further functional recovery can be achieved in humans with training. Treadmill training represents a functional activity and is purposeful bilateral hemisphere activity. Recent clinical studies have shown that treadmill training is effective with regard to restoration of gait ability and improvement of gross motor efficiency.⁷⁶

Newmann and colleagues reported that a four-week aerobic treadmill training program resulted in an increased walking endurance, more normal time-spatial gait pattern, increased self-selected walking speed and a decrease in walking effort.

Past results suggest that treadmill training improved balance and walking capacity, fatigue and quality of life in people with mild to moderate MS.⁷³

Other past study showed that treadmill training in MS individuals is feasible, well tolerated and increases gait speed and endurance, and importantly does not worsen symptoms of fatigue.⁷⁰

In this experimental study both the Control group and Experimental group showed improvements in the post test parameter of TUG, MFIS, BBS, as compared to the pretest parameters.

The results of this experimental study reveal that participants in the PNF group who participated in 4 week program showed significant improvements in basic mobility, balance and reducing fatigue post treatment.

Past studies have shown that both interventions of PNF and treadmill training were effective for improving mobility, balance, and reducing fatigue in patients with MS. Past result also shows that PNF techniques can be as effective as or more effective than other well-known treatment approaches, for both children and adults⁶¹.

PNF is a method of neuromuscular dysfunction treatment, primarily by means of facilitating the flow of information, mainly by the stimulation of proprioceptors. Restoration of normal movement based on movement patterns, basic principles and techniques is directed towards normalization of muscle tone.⁵⁴ In this multisensory approach of Proprioceptive Neuromuscular Facilitation (PNF), basic procedures of facilitation are superimposed on movement pattern through the therapist's manual contact, verbal commands and visual cues and also resistance, irradiation and reinforcement, body position and body mechanics, traction and approximation, stretch, timing.¹⁷

The treadmill allows systematic control and progression of the speed at which walking is performed, and the repetitive training of a complete gait cycle enables a more appropriate pattern of sensory input associated with the different phases of gait to stimulate the locomotor pattern.⁷⁵

In particular, aerobic exercise seems to be a promising rehabilitative tool for patients with MS because it could positively affect both maximum exercise capacity and daily physical activities.⁷³ The training exercise made walking on a treadmill less energy expensive, particularly at higher speeds, albeit with individual differences.⁷²

For experimental group the intensity of PNF for lower limb given for 4 weeks was sufficient to produce significant improvement in TUG score, MFIS and BBS.

Earlier investigations of the effect of outpatient programmes and aerobic cycling. Improved

walking performance did not transfer into changes in overall disability.⁷⁰

Kileff and Ashburn found that 24 biweekly sessions of 30 minutes of cycling on a stationary bicycle improved walking distance. In that study, the mean improvement in 6MWT walking distance was 32 m.⁷¹ However, it was found that the training effects returned towards baseline scores within the follow up period. The rate of detraining observed in this clinical group suggests that longer interventions or an ongoing maintenance program might be more effective than short intervention.⁷⁰ Hence, this can be one reason of lesser effects of treadmill training as compared to PNF training.

Conclusion and Clinical Significance

Conclusion

Proprioceptive neuromuscular facilitation techniques incorporate movement in the three planes of the body. According to the International PNF Association, the PNF approach is considered to be a conceptual approach. Some authors regard it as a method. The differences in considering the terms, concept and method become clear by the description of using components of the PNF approach and the clinical reasoning in making up a treatment strategy. Whether promoting flexibility, developing functional movement, developing muscular strength and endurance, improving joint stability, or increasing neuromuscular coordination and control, PNF technique ie. dynamic slow reversal, as proven in this study, should be incorporated into the physical therapy setting as a valuable and efficacious component of rehabilitation for patients with multiple sclerosis.¹⁹

Clinical significance

PNF exercises can be applied to patients of all ages. From this study it is clear that the dynamic slow reversal PNF technique was superior to control group in improving the balance, mobility and fatigue in patients with multiple sclerosis, hence such patients can be given dynamic slow reversal PNF technique for improving their balance, mobility and reducing fatigue.

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