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Research Article

Evaluation of Proprioceptive Neuromuscular Facilitation (PNF) and Therapy Hand Ball to Improve Motor Dexterity in Post-Stroke Patients

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Abstract: Stroke is the leading cause of disability and can cause various degrees of disturbance, such as decreased muscle tone, loss of sensation in various body parts, and limitations in moving the affected limbs to perform certain activities. This study aimed to see the effectiveness of the Proprioceptive Neuromuscular Facilitation (PNF) (Contract-Relax) technique and Therapy handball exercises in improving the motor skill of the affected hand in non-haemorrhagic post-stroke patients. The sample for this study was 30 patients and were divided into two groups (Group A & Group B), 15 patients each. Both groups were given conventional physiotherapy before starting with the interventions respectively. Box and Block tests and Bardel index were performed pre-treatment and post-treatment to see the changes and for the outcome measurement. PNF(Contract-Relax) technique was given in sets of three, five days a week, and Therapy Hand Ball exercises in three, five days a week for three weeks. Both interventions were given to every individual in both Groups. This study found that both groups have improved motor dexterity of the hand (affected side), with better improvement observed for the group that did the Therapy Hand Ball exercises compared to the PNF(Contract-Relax) technique. From the data analysis of the prolonged treatment Therapy, Hand Ball exercises showed better results when compared to the Proprioceptive Neuromuscular Facilitation PNF (Contract-Relaxed) Technique, as Therapy Hand Ball exercises can be easily performed at home by the patient himself , whereas the PNF CR technique needs a Physiotherapist to perform the treatment

Keywords:- Non-Haemorrhagic stroke, Proprioceptive Neuromuscular Facilitation (PNF) (Contract-Relax) technique, Therapy Hand Ball, Box And Block Test

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1. INTRODUCTION

Stroke is one of the leading causes of mortality and disability[1]. Worldwide, cerebrovascular accidents (stroke) are the second leading cause of death and the third leading cause of disability[2]. Stroke is the second most common cause of death in India; about 185000 stroke cases are reported annually in India, with nearly one stroke every 40 seconds. It is an acute, neurological incident that is caused by a reduction of blood supply to the brain or sudden death of some brain cells due to lack of oxygen when the blood flow to the brain is lost by blockage or rupture of an artery to the brain, is also a leading cause of dementia and depression[4]. The term stroke is synonymous with cerebrovascular accident. According to the World Health Organization, it can be defined as a "rapidly developed clinical sign of a focal disturbance of cerebral function of presumed vascular origin and more than 24-hours duration[3,4]. Stroke is categorized into two types, namely Ischemic Stroke and Hemorrhagic stroke. When the disruption of blood supply to the brain is caused by occlusion of the cerebral blood vessels, it is called ischaemic stroke. It is the most common type, affecting about 80% of individuals with stroke, and results when a clot blocks or impairs the blood flow, depriving the brain of essential oxygen and nutrients. Meanwhile, haemorrhagic stroke occurs when blood vessels rupture, causing leakage of blood in and around the brain, preventing blood flow to the brain[4]. The time after a stroke is often divided into phases. The Stroke Roundtable Consortium proposed designating the following phases: the first 24 hours as the hyperacute phase and the first 7 days as the acute phase. The first 3 months are the early sub-acute phase, months 4–6 are the late sub-acute phase, and From 6 months on is the chronic phase.[5]The rationale behind this differentiation is that recovery-related processes post-stroke are time-dependent. Already within hours after the onset of cerebral ischemia, a cascade of plasticity-enhancing mechanisms leads to dendritic growth, axonal sprouting, and the formation of new synapses[6,7]. Globally, 70% of strokes and 87% of stroke-related deaths and disability-adjusted life years occur in low- and middle-income countries[33]. Proprioceptive Neuromuscular Facilitation (PNF) is a stretching technique utilized to improve muscle elasticity and has been shown to positively affect active and passive range of motions [14]. Therapy handballs are used to increase the strength and dexterity of the hands, and they are easily available and affordable and a great exercise option. Therapy handball exercises are simple and extremely versatile, making it easy to practice a wide range of effective exercises to strengthen and improve the motor dexterity of the hand[12].There are studies where the proprioceptive neuromuscular facilitation (contract-relax) technique, as a preparation method before performance, can enhance the efficacy of training better to learn the coordination pattern of fine motor skills[3]. There are articles where therapy handballs are used to increase the strength and dexterity of one's hand after a stroke. Extremely versatile and simple, making it easy to practice a wide range of effective exercises to strengthen the hands.[6]But there is a lack of studies comparing the effectiveness of the PNF (contract-relaxed) method and the use of therapy handball to improve motor dexterity in hemiparaetic hand of non-haemorrhagic post-stroke patients. This study aimed to determine the effectiveness of the Proprioceptive Neuromuscular Facilitation (PNF) (Contract-Relax) technique and Therapy Hand Ball exercises in improving the motor dexterity of the affected hand in non-haemorrhagic post-stroke patients.

2. MATERIALS AND METHODS

2.1. Study Design

The study was a comparative design study carried out with 30 males and females, with a diagnosis of post-stroke by a physician with hemiparetic hand recruited for the study. 10 females and 20 males were present in the study. 30 patients were recruited through random selection. Each patient was explained about the study, and after receiving consent forms from the patients with Ethical approval from Assam Down Town University with Approval (AdtU/Ethics/stdnt-lett/2022/31). The study was conducted at the physiotherapy OPD of Assam downtown university, private clinics (Incentive Physiotherapy Clinic), and patients living in their homes. The duration of the study was 6 months, wherein the patients received therapy from the therapist.

2.2. Inclusion criteria

The study included both males and females, with

1. Diagnosed non-haemorrhagic stroke
2. Without any prior history of stroke
3. Hemiparetic hand
4. Age between 45-70 years.
5. Brunstrom motor recovery stages
   Stage 4: Spasticity begins to decrease; four movement combinations deviate from basic limb synergies and become available
   Stage 5: There is relative independence of the basic limb synergies.

2.3. Exclusion criteria

The study excluded

1. Patients not willing to participate in the study
2. Individuals with musculoskeletal disorders
3. Neurological disorders, e.g., ataxia.
4. Visual impairment
5. Previously/already diagnosed with psychological disorders

2.4. Functional Motor Skills and Manual Dextirity

Box and Block test: - Three tests using the affected hand

1. sBBT (Standard Box and Block Test)
2. mBBT (Modified Box and Block Test)
3. tBBT (Transport Box and Block Test)

- sBBT: - Transport as many blocks as possible in 60 seconds over the partition using the affected hand
- mBBT: - Transport each block over the partition as quickly as possible, starting with the innermost left block and moving across the row
- tBBT:- Transport each block as quickly as possible using the affected hand from the innermost left block over the partition, moving across the row, and accurately placing it in the mirrored position.

2.5. *Background Measures*

1. Response to light touch on the back of the hand was used to assess sensory loss, detect passive movement of the thumb tip, and Thumb Finding Test.

2. Functional independence was assessed using the Barthel ADL Index (This was based on questioning family members or anyone who knows the patient well. Here, only those activities involving the hand's functioning were used.

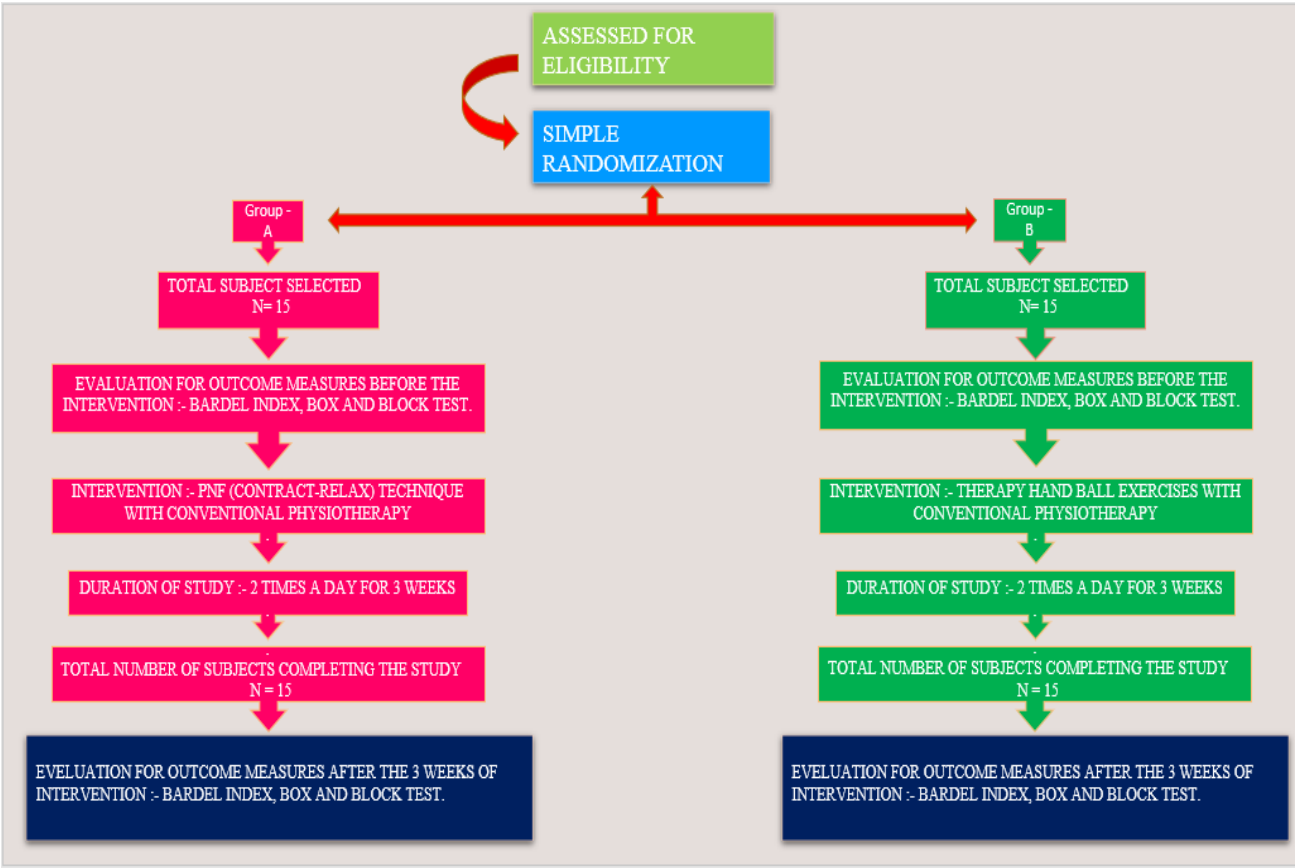


Fig 1: Study flow chart

3. PROCEDURE

The subjects were assigned into two groups: Group (A) PNF (Contract-Relax) technique & Group (B) Therapy Hand Ball, with conventional physiotherapy before the intervention for both groups. Both groups had 15 patients each after random sampling. Pre and post-tests were conducted on both groups by Box and Block Test and Barthel Index. All the patients received intervention two times a day for three weeks (i.e., Two times a day for twenty-one days), that is, 42 sessions.

3.1. *Both Groups (A & B) received conventional physiotherapy before the interventions Fig.2 (a – j).*

They consist of full range of motion (ROM) exercises – passive and active-assisted range of motion exercises for the affected limb, including shoulder (flexion, extension, abduction, and adduction), elbow (flexion and extension), forearm (supination and pronation), wrist (flexion, extension, radial and ulnar deviation)[10].

Fig.2(a) Fig.2(b) Fig.2(c)

Fig.2(d) Fig.2(e) Fig.2(f)

Fig.2(g) Fig2.(h) Fig2.(i)

Fig2. (j)

Fig.2 (a, b, c, d, e, f, g, h, i, j) conventional physiotherapy for upper affected limb

3.2. Group A (PNF (Contract-Relax) Technique)

The treatment started with conventional physiotherapy of range of motion for the upper limb[8]. The patient was in a sitting position.Passive placement of the restricted muscle into a position of stretch followed by an isometric contraction of the restricted muscle held for a minimum of 3-5 seconds at a sub-maximal effort (20-50%) to avoid muscle fatigue and injury. After this exercise, the subject is allowed to get their muscle relaxed for 10 sec and activate the opposing muscle to move into a greater position of the stretch, 3 sets of six, 5 days a week .[3,4,11]

Fig.3(a) Fig.3(b) Fig.3(c) Fig.3(d)

Fig.3 (a,b,c,d) PNF (contract-relax) technique

3.3. Group B (Therapy Hand Ball).

The patient was made to be in a sitting position with a table in front. All the subjects from group B received therapy handball exercises in sets of 10 repetitions of each exercises[6], 2 times a day for 5 days a week[2]. The following are the therapy handball exercises (Power Grip, Pinch, Thumb Extension, Table Roll, Finger Flexion, Thumb Roll, Finger Squeeze, and Thumb Opposition)

Fig.4(a). Squeezing the ball with all the fingers and thumb, making a fist, then releasing the ball completely, opening the fingers as wide as possible. This hand therapy ball exercise will help strengthen one's grip, making it easier to grab objects, pick them up, and release them[12].

Fig.4(b). Pinch the hand therapy ball with all fingers and thumb extended. And by extended means, keep all your fingers straight. This will help strengthen different muscles than the ones targeted by curled fingers [12].

Fig.4(c). With the palm flat (as flat as you can), place the therapy ball on the palm and use the thumb to keep it in place. Then, use the thumb finger to roll the ball up and down the palm [12].

Fig.4(d). Place the therapy handball on a table and place one hand on top of it. Then, while keeping a flat hand, roll the ball from the base of the palm up to the fingertips [12].

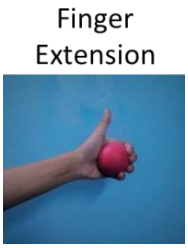


Fig.4(e). Hold the therapy handball on the palm and press into it using all fingers except the thumb. Press and release. It is much more challenging to squeeze the ball without using the thumb. This will help strengthen the muscles that allow you to bend the fingers [12].

Fig.4(f). This therapy hand exercise isolates the thumb and encourages it to move through its entire range of motion. As a result, it will help prevent stiffness and improve control. Place the therapy handball on the palm. Keep the palm flat and use the thumb to keep it in place. Then, use the thumb to roll the ball in a circle on the palm[12].

Fig.4(g). Place the therapy ball between two fingers and squeeze the fingers together. Squeeze and release. One can do this between any combination of fingers, so exercise all the fingers. Some fingers will be more difficult than others (like your ring and pinkie finger), so pay attention to them[12].

Fig.4(h).This therapy handball exercise is similar to the Thumb Roll, but one will roll the ball side-to-side instead of in circles. Start by placing the therapy ball on the palm and use the thumb to keep it in place. Then, use the thumb to move the ball from left to right[12].

Fig.4 (A-H) Therapy Hand Ball exercises

4. OUTCOME MEASURES

The Box and Block Test and Barthel Index were used for the outcome measures to assess the motor dexterity of the hand of the subjects and to evaluate the improvements.The standard BBT is a useful measure due to its ease and speed of implementation, reliable and objective measurement, and repetition of motion..[19, 20]The same instructions in the standard BBT applied for the transport of the blocks in the modified BBT; here an additional instruction was introduced, that requires the user accurately place each block in a specific position on the opposite side of the partition. Sheets of paper on which were printed identical 4x4 grids inside of the box on each side of the partition (see Fig 5), giving participants a target within which to place the blocks. This allowed a quantitative study of initiation, grasping, and transport of objects and object release[21].The targeted Box and Blocks Test (tBBT) still allows analysis of repetitive movements. Still, it may more closely model common real-world object manipulation scenarios where users must control a movement from pick-up to release. Several studies have shown the utility of motion capture in quantifying movement of the upper limb[22-24].

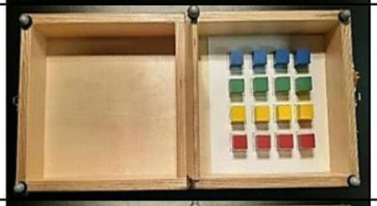
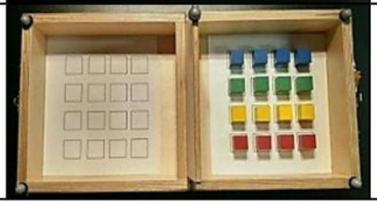
Task type	Initial configuration	Task description
sBBT		• Transport as many blocks as possible in 60 seconds over the partition using only the dominant hand • At a minimum, the fingertips of the dominant hand are required to cross the plane of the partition • Score defined by the number of blocks transported within the time limit
mBBT		• Transport each block over the partition as quickly as possible, starting the with innermost left block and moving across the row. • At a minimum, the fingertips of the dominant hand are required to cross the plane of the partition • Score defined by the time required to transport all 16 blocks.
tBBT		• Transport each block over the partition using only the dominant hand, starting the with innermost left block and moving across the row, and place it in its mirrored position as quickly and accurately as possible • Score defined by the time required to transport all 16 blocks.

Fig.5 The Box and Block Test.

Barthel ADL index: Measure of physical disability used widely to assess behaviour relating to activities of daily living for stroke patients or patients with other disabling conditions. It measures what patients do in practice. Assessment is made by anyone who knows the patient well[31]. In this study, only activities involving the hand function are used, with a total score of 5.

Bathing 0 = Dependent I= Independent (bath or shower)	**Grooming** 0 = Needs help with personal care I= Independent (including face, hair, teeth, shaving
Feeding 0 = Unable 1 = Needs help, e.g. cutting 2 = Independent	**Dressing** 0 = Dependent 1 = Needs help – can do ~ ½ unaided 2 = Independent (including buttons, zips, laces, etc.)

Fig 6. Barthel Index.

5. STATISTICAL ANALYSIS

Descriptive data was presented as mean ± standard deviation and number (percentage). The paired sample test and independent sample test were used to compare the results after three weeks of treatment in each group. Significant changes were observed in both groups concluding that the possibility of the PNF (contract–relax) technique and Therapy Hand Ball Exercises were equally effective in improving the motor dexterity in a hemiparetic hand of non-haemorrhagic post-stroke patients.

6. RESULTS

The study was done for 6 months, comparing the effectiveness of either the Proprioceptive Neuromuscular Facilitation (PNF) Contract- Relax technique or Therapy Hand Ball in improving the motor dexterity of hand in non-haemorrhagic post-stroke patients.

Table 1:Background Characteristics of Patients

	Group A	Group B
Minimum Age	45.00	47.00
Maximum Age	69.00	66.00
Age (Mean +SD)	59.13+ 6.62	57.86+6.11

In the study, 30 subjects were selected by random sampling method and then allocated to Group A and Group B. In Group A, the mean age was 59.13 years, ranging from 45 to 69 years. In Group B, the mean age was 57.86 years, ranging from 47 to 66 years.

Table 2:Distribution of the patients according to their age				
Age	Group A		Group B	
	Frequency	Percent	Frequency	Percent
45 - 50 Years	2	13.3	2	13.3
50-55 Years	1	6.7	2	13.3
55-60 Years	3	20.0	4	26.7
60 -65 Years	6	40.0	6	40.0
65 - 70 Years	3	20.0	1	6.7
Total	15	100.0	15	100.0

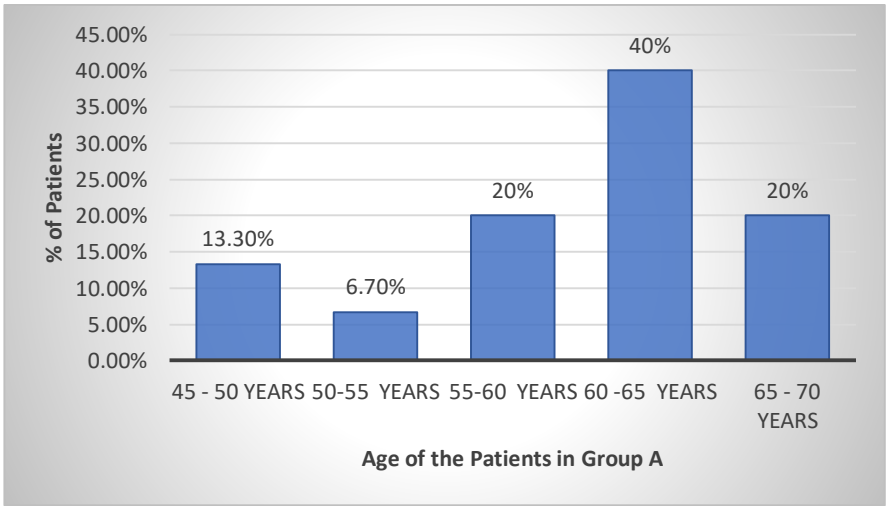


Fig.7(a): Age distribution of the patients in Group A (PNF technique)

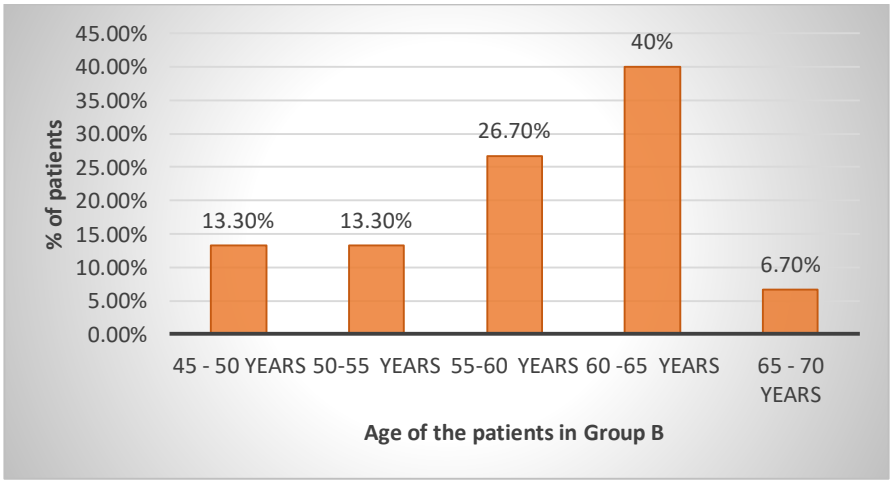


Fig.7(b): Age distribution of the patients in Group B (Box and Block test)

Table 3:Distribution of the patients according to their gender				
Gender	Group A		Group B	
	Frequency	Percent	Frequency	Percent
Female	5	33.3	5	33.3
Male	10	66.7	10	66.7
Total	15	100.0	15	100.0

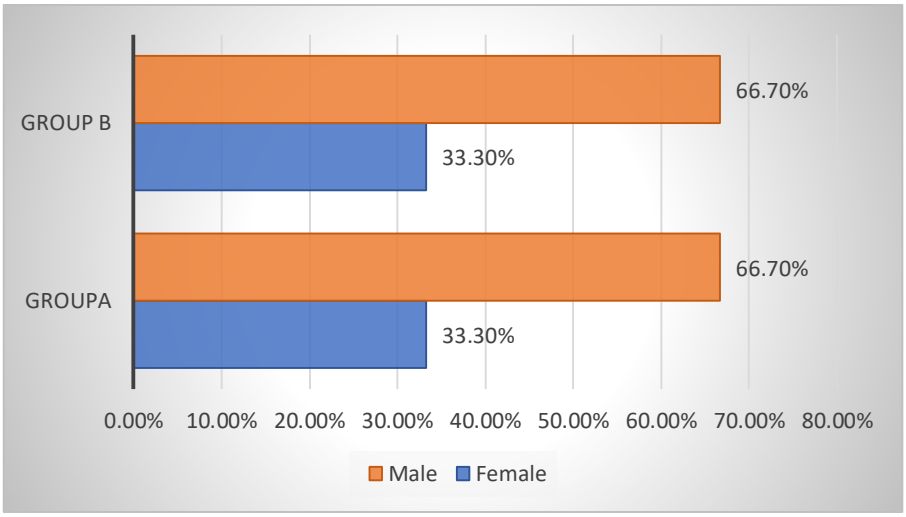


Fig.8: Gender distribution of the patients in Group A and Group B

7. INITIAL ARM ASSESSMENT

Table 4:Distribution of the patients according to their affected side

Affected Side	Group A		Group B	
	Frequency	Percent	Frequency	Percent
Left	7	46.67	6	40
Right	8	53.33	9	60
Total	15	100.0	15	100.0

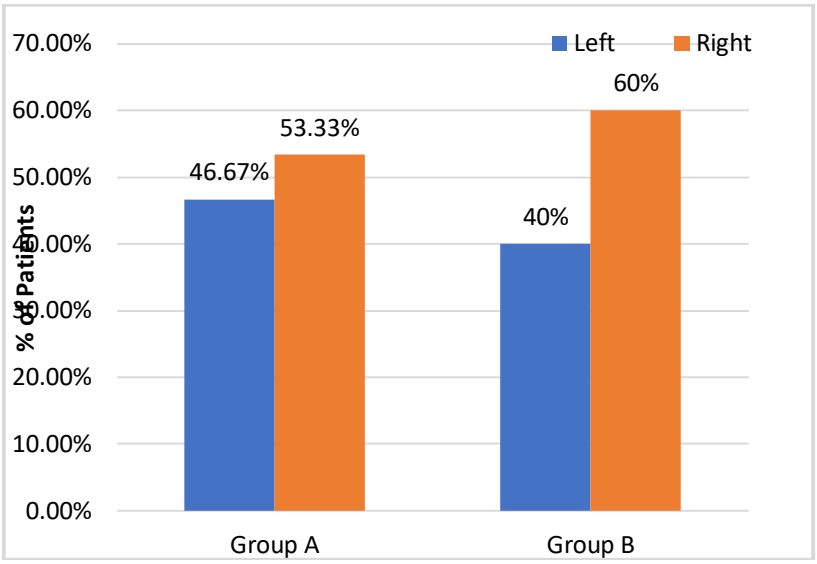


Fig.9: Distribution of the patients in Group A and Group B according to the affected side

Conventional physiotherapy of the affected upper limb was performed for groups A and B before the intervention. The Group A PNF (contract-relax) technique was performed after conventional physiotherapy. Also, Group B was given Therapy Hand Ball exercises after conventional physiotherapy. Both groups' subjects were assessed to see the motor dexterity of the hand using The Box and Block Test and the Barthel Index. A pre-test and post-test score of each outcome measure were recorded. Group A and Group B showed equal comparison in their motor dexterity of the hand before both interventions. Barthel Index of the patients of both the groups also showed equal comparison before the intervention.

Table 5: Background characteristics and hand assessment at three weeks

		Mean	N	Std. Dev	t	df	p
sBBT	Before Treatment	2.1033	15	.58860	5.428	14	0.00**
	After Treatment	1.6900	15	.45017			
mBBT	Before Treatment	1.5887	15	.43855	5.561	14	0.00**
	After Treatment	1.2413	15	.48319			
tBBT	Before Treatment	1.7387	15	.47718	5.341	14	0.00**

	After Treatment	1.4360	15	.40467			
Barthel Index	Before Treatment	1.6667	15	.97590	-9.057	14	0.00**
	After Treatment	3.7333	15	1.27988			

NS: Not Significant: *; Significant at 5%; **: Significant at 1%

The above table is constructed to see whether the PNF technique can improve the motor dexterity of a hemiparetic hand of non-haemorrhagic post-stroke patients.A paired t-test was performed to see the significant difference in sBBT, mBBT, tBBT, and Barthel Index before and after treatment.

7.1. Test for sBBT

It was found that t = 5.428, which is highly significant at 1% probability level, sBBT decreased remarkably after treating the patients with the PNF technique. Hence, the PNF technique effectively improves the motor dexterity of a hemiparetic hand of non-haemorrhagic post-stroke patients.

7.2. Test for mBBT

It was found that t = 5.561, which is highly significant at 1% probability level. mBBT decreased remarkably after treating the patients with the PNF technique. Hence, the PNF technique effectively improves the motor dexterity of a hemiparetic hand of non-haemorrhagic post-stroke patients.

7.3. Test for tBBT

It was found that t = 5.341, which is highly significant at 1% probability level. tBBT decreased remarkably after treating the patients with the PNF technique. Hence, the PNF technique effectively improves the motor dexterity of a hemiparetic hand of non-haemorrhagic post-stroke patients.

7.4. Test for Barthel Index

It was found that t = -9.057, which is highly significant at 1% probability level. Barthel Index increased remarkably after treating the patients with the PNF technique.Hence, the PNF technique effectively improves the motor dexterity of a hemiparetic hand of non-haemorrhagic post-stroke patients. Hence, seeing the results of Table 4, the PNF technique was useful in improving the motor dexterity of a hemiparetic hand of non-haemorrhagic post-stroke patients.

Table 6: Background characteristics and hand assessment at three weeks

		Mean	N	Std. Dev	t	df	p
sBBT	Before Treatment	2.0713	15	.59344	5.873	14	0.00**
	After Treatment	1.4473	15	.37009			
mBBT	Before Treatment	1.5233	15	.50381	6.397	14	0.00**
	After Treatment	1.0207	15	.37425			
tBBT	Before Treatment	1.7153	15	.46634	6.296	14	0.00**
	After Treatment	1.2333	15	.38362			
Barthel Index	Before Treatment	2.0667	15	.88372	-7.278	14	0.00**
	After Treatment	4.1333	15	1.12546			

NS: Not Significant: *; Significant at 5%; **: Significant at 1%

The above table is constructed to see whether the Therapy Hand Ball Exercise technique can improve the motor dexterity of a hemiparetic hand of non-haemorrhagic post-stroke patients.A paired t-test was performed to see the significant difference in sBBT, mBBT, tBBT, and Barthel Index before and after treatment.

7.5. Test for sBBT

It was found that t = 5.873, which is highly significant at 1% probability level. sBBT decreased remarkably after treating the patients with Therapy Hand Ball Exercises. HenceTherapy Hand Ball Exercise effectively improves the motor dexterity of a hemiparetic hand of non-haemorrhagic post-stroke patients.

7.6. Test for mBBT

It was found that t = 6.697, which is highly significant at 1% probability level. mBBT decreased remarkably after treating the patients with Therapy Hand Ball Exercises. Hence, Therapy Hand Ball Exercise effectively improves the motor dexterity of a hemiparetic hand of non-haemorrhagic post-stroke patients.

7.7. Test for tBBT

It was found that t = 6.296, which is highly significant at 1% probability level. tBBT decreased remarkably after treating the patients with Therapy Hand Ball Exercises. Hence, Therapy Hand Ball Exercise effectively improves the motor dexterity of a hemiparetic hand of non-haemorrhagic post-stroke patients.

7.8. Test for Barthel Index

It was found that t = -7.278, which is highly significant at 1% probability level. Barthel Index increased remarkably after treating the patients with Therapy Hand Ball Exercises. Hence Therapy Hand Ball Exercise is effective in improving the motor dexterity of a hemiparetic hand of non-haemorrhagic post-stroke patients. Hence, seeing the results of Table 5, Hand Ball Exercise was useful in improving the motor dexterity of a hemiparetic hand of non-haemorrhagic post stroke patients.

Table7:Post Treatment							
	Treatment	Mean	N	Std. Dev	t	df	p
sBBT	PNF	1.6900	15	.45017	1.613	14	.118 NS
	Hand Ball Exercise	1.4473	15	.37009			
mBBT	PNF	1.2413	15	.48319	1.398	14	.173 NS
	Hand Ball Exercise	1.0207	15	.37425			
tBBT	PNF	1.4360	15	.40467	1.408	14	.170 NS
	Hand Ball Exercise	1.2333	15	.38362			
Barthel Index	PNF	3.7333	15	1.27988	-.909	14	.371 NS
	Hand Ball Exercise	4.1333	15	1.12546			

NS: Not Significant: *; Significant at 5%; **: Significant at 1%

An Independent t-test was performed to observe the effectiveness of the proprioceptive neuromuscular facilitation (PNF) (contract-relax) technique versus the use of Therapy Hand Ball in improving the motor dexterity in a hemiparetic hand of non- haemorrhagic post stroke patients. Independent t-test was performed for the comparison of motor dexterity.

7.9. Comparison of sBBT

It was found that t = 1.613, which is not significant. Hence sBBT of the patients of both the groups was equal after treatment.

7.10. Comparison of mBBT

It was found that t = 1.398, which is not significant. Hence mBBT of the patients of both the groups was equal after treatment.

7.11. Comparison of tBBT

It was found that t = 1.408, which is not significant. Hence tBBT of the patients of both the groups was equal after treatment.

7.12. Comparison of Barthel Index

It was found that t = -.909, which is not significant. Hence, the Barthel Index of the patients of both groups was equal after treatment.PNF techniques Hand Ball Exercises were equally effective in improving the motor dexterity in a hemiparetic hand of non- haemorrhagic post stroke patients.

8. RECOVERY CURVES

8.1. Extended Motricity Index

From Table 1 (Group – A), after the treatment for three weeks, a Paired t-test for sBBT was found at t = 5.428, which is highly significant at 1% probability level.

A paired t-test for mBBT was found at t = 5.561, which is highly significant at 1% probability level.
A paired t-test for tBBT was found at t = 5.341, which is highly significant at 1% probability level. Hence inferring that PNF (Contract-Relax Technique) successfully improved the motor dexterity of the affected hand.

From Table 2 (Group – B), after three weeks of treatment, a Paired t-test for sBBT was found at t = 5.873, which is highly significant at 1% probability level.

A paired t-test for mBBT was found at t = 6.697, which is highly significant at 1% probability level.
Paired t-test for tBBT was found at t = 56.296, which is highly significant at 1% probability level. Hence, inferring that Therapy Hand Ball exercises successfully improved the motor dexterity of the affected hand.

8.2. Test for Barthel Index

Both Groups showed improvement.

Group A Paired t–test was found at t = -9.057, which is highly significant at 1% probability level.
Group B Paired t–test was found at t = -7.278, which is highly significant at 1% probability level.
Hence, the Barthel Index showed significant improvement after the complete treatment of both interventions,

9. DISCUSSION

This study aimed to compare the effectiveness of the Proprioceptive Neuromuscular Facilitation PNF Contract-relaxed technique (Group – A) verses the Therapy Hand Ball (Group – B) to improve the motor dexterity of hand in non-haemorrhagic post stroke patients. PNF techniques do increase ROM[13, 27]. One of the PNF techniques is more frequently used when compared to others in literature, the contract-relax method (CR). The CR method included the target muscle (TM) being lengthened and held in that position while the participant contracted the TM to its maximum isometrically for an allotted amount of time[28]. This was followed by a shorter relaxation of the TM that usually included a passive stretch[29].This study also concluded that PNF stretching, the CR (Contract-Relaxed) method, effectively improves and maintains ROM, increases muscular strength and power, and increases athletic performance, especially after exercise[13].The study also had Group-B-B – B, where Therapy Hand Ball was used; the study has shown that hand exercise using a rubber ball can be utilized as an alternative physical rehabilitation as it is cheap, simple, and easy to perform at home[1]. They are useful in increasing the strength and dexterity of the hands; their exercises are simple and extremely versatile, making it easy to practice a wide range of effective exercises to strengthen and improve the motor dexterity of the hand[12].The group's outcome measures comprised The Box and Block Test and Barthel Index. The Box and Block Test (BBT) is a test (functional outcome measure) used across multiple clinics, where the functions of the hand can be measured using different box and block test approaches. A study done by Kimberly Kontson, Ian Marcus, Barbara Myklebust, Eugene Civillicoon(Normative data and comparison to standard

tests) uses some modifications to the existing test that may increase the ecological validity of the measure while still retaining the previously stated benefits of the standard BBT they are StandardBBT, ModifiedBBT and TransferBBT.[30].Barthel Index is the measure of physical disability used widely to assess behaviour relating to activities of daily living for stroke patients or patients with other disabling conditions. It measures what patients do in practice. Assessment is made by anyone who knows the patient well [31, 32]. Here, certain changes were made. In the study, only the function of the hand was needed. Hence, only those activities that involved the use of the hand were taken out, and the total possible score ranged from 0-8, with a lower score indicating disability. Changes of more than two points in the total score would reflect a probable genuine change.So, in this study, before the conventional physiotherapy and the interventions on both Groups A and B, the outcome measures of Box and Block Test and Barthel Index didn't show any significant changes, hence confirming that outcome measures on both the groups were equal. The outcome measures for Group A showed significant changes between the pre and post-treatment. A paired t-test was performed to see the significant difference in sBBT (Purdue Pegboard Test), mBBT (Modified Box and Block Test), tBBT (Total Box and Block Test), and Barthel Index before and after treatment. The results showed that there was a highly significant improvement in all the parameters assessed (sBBT: $t = 5.428$, $p < 0.01$; mBBT: $t = 5.561$, $p < 0.01$; tBBT: $t = 5.341$, $p < 0.01$; Barthel Index: $t = -9.057$, $p < 0.01$). These results suggest that the treatment improved motor dexterity and functional independence in patients with non-haemorrhagic post-stroke. Thus, the treatment effectively improved the patient's ability to use their hands and perform daily activities.Hence, we can infer that the PNF (Contract-Relaxed) technique was useful in improving the motor dexterity of a hemiparetic hand of non-haemorrhagic post stroke patients.The outcome measures for Group B (Therapy Hand Ball exercises) also showed significant changes between the pre and post-treatment. A paired t-test was performed to see the significant difference in sBBT (Purdue Pegboard Test), mBBT (Modified Box and Block Test), tBBT (Total Box and Block Test), and Barthel Index before and after treatment.The results showed that there was a highly significant improvement in all the parameters assessed (sBBT: $t = 5.873$, $p < 0.01$;mBBT: $t = 6.697$, $p < 0.01$;tBBT: $t = 6.296$, $p < 0.01$; Barthel Index: $t = -7.278$, $p < 0.01$)These results suggest that Therapy Hand Ball exercises are an effective treatment for improving motor dexterity and functional independence in patients with non-haemorrhagic post-stroke.Thus, Therapy Hand Ball exercises effectively improved patients' ability to use their hands and perform daily activities. Barthel Index increased remarkably after treating the patients with Therapy Hand Ball Exercises. Hence Therapy Hand Ball Exercise is effective in improving the motor dexterity of a hemiparetic hand of non-haemorrhagic post stroke patients. An Independent t-test was performed to compare the comparative study between the neuromuscular facilitation (PNF) (contract-relax) technique and Therapy Hand Ball in improving the motor dexterity in a hemiparetic hand of non-haemorrhagic post-stroke patients. The results showed that there was no significant difference between the two interventions in terms of improving sBBT ($t = 1.613$, $p > 0.05$), mBBT ($t = 1.398$, $p > 0.05$), tBBT ($t = 1.408$, $p > 0.05$), and Barthel Index ($t = -0.909$, $p > 0.05$).

10. LIMITATIONS

- This study consisted of a short course of treatment of 30 therapy sessions.
- The result only showed the short-term effects of the interventions.
- The sample size was small.

11. CONCLUSION

Both interventions showed improvement in each group post-treatment based on the mean score. So, this study can conclude that the treatment protocol, PNF Contract-Relaxed technique, and Therapy Hand Ball exercise significantly improve the motor dexterity of the hand in non-haemorrhagic post stroke patients. In conclusion, PNF (Contract-Relaxed) techniques and Therapy Hand Ball Exercises (Both Interventions) were equally effective in improving the motor dexterity of the hand in non-haemorrhagic post-stroke patients. From the data analysis, the prolonged Therapy Hand Ball exercises would show better results when compared to the Proprioceptive Neuromuscular Facilitation PNF (Contract-Relaxed) Technique, as Therapy Hand Ball exercises can be easily performed at home by the patient. At the same time, the PNF CR technique needs a Physiotherapist to perform the treatment. Also, the therapy handballs are easily available, cheap, and can be used anywhere.

12. AUTHORS CONTRIBUTION STATEMENT

Tongpangmeren, an MPT scholar, carried out the research work in data collection review of the literature and prepared the thesis as part of the curriculum of the Masters of Physiotherapy. Dr. Trishna Saikia Baruah (PT) (Corresponding Author), Assistant Professor, Assam Downtown University, guided as the main guide in the whole study along with the topic selection, literature reviews, methodology, results analysis, and discussion of the study. Dr. Niharika Dihidar (PT), Assistant Professor, Assam Down Town University, contributed to the study as the co-guide and guided in literature reviews, data collection, discussion, and the methodology part. Dr. Abhijit Dutta, Associate Prof., Associate Dean Faculty of Paramedical Sciences, Assam Downtown University, guided in literature reviews and discussion part. Dr.Mantu Paul(PT), Assistant Professor, Assam Downtown University, guided the literature reviews and discussion part.

13. CONFLICT OF INTEREST

Conflict of interest declared none.

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