# Effect on Gait Performance in MCA Territory Stroke Patients Using Designed Structured Exercise Protocol Versus Conventional Exercises

**Dr. Smrutika Shinde[1], Dr. Shimpa Sharma[2]***

[1]MPTh, Assistant Professor, Department of Neurosciences, D. Y. Patil College of Physiotherapy, D. Y. Patil Education Society (Deemed to be university), Kolhapur
[2]MD, Professor, Department of Medicine, D. Y. Patil Medical College Hospital and Research Institute, Kolhapur, D. Y. Patil Education Society (Deemed to be university), Kolhapur

**Abstract**

Background: Stroke is a major cause of disability worldwide, with gait impairment being one of its most disabling sequelae. Physiotherapy plays a crucial role in promoting neuroplasticity and restoring functional mobility. A structured exercise protocol (SEP-G) may provide greater improvements in gait performance than conventional rehabilitation exercises. Methods: A prospective interventional study was conducted over two years in a tertiary care hospital. Eighty patients with unilateral MCA territory stroke were randomly allocated into two groups: Structured Exercise Protocol (SEP-G, n=40) and Conventional Therapy (CT, n=40). Both groups underwent supervised physiotherapy sessions three times per week for four weeks. Gait performance was assessed using stride length, step length, cadence, walking speed, and the 2-Minute Walk Test (2MWT). Within-group comparisons were performed using paired t-tests, while between-group comparisons were analyzed using unpaired t-tests. Results: Both groups demonstrated significant improvements following intervention. In the SEP-G group, significant improvements were observed in stride length (p=0.036), step length (p=0.001), cadence (p=0.001), walking speed (p=0.001), and 2MWT distance (p=0.001). The conventional therapy group also showed significant improvements in stride length (p=0.001), step length (p=0.007), cadence (p=0.001), and 2MWT distance (p=0.003), whereas improvement in walking speed was not statistically significant (p=0.371). Between-group comparison revealed significantly greater improvements in cadence (p=0.001) and walking speed (p=0.001) in the SEP-G group, while differences in stride length, step length, and 2MWT distance were not statistically significant. Conclusion: Both structured exercise protocol and conventional exercises effectively improved gait performance in patients with MCA territory stroke. However, the structured exercise protocol produced superior improvements in cadence and walking speed, indicating that it may be a more effective rehabilitation strategy for enhancing gait performance after stroke

**Keywords:** Stroke; Middle cerebral artery; Gait rehabilitation; Structured exercise protocol; Conventional physiotherapy; Cadence; Walking speed; Neuroplasticity

## 1. Introduction

Worldwide, stroke is the third leading cause of mortality and morbidity combined and the second leading cause of death. [1-2] In India, among all deaths and disabilities, strokes cause 7.3% and 3.5% of deaths and disabilities, respectively. [3] A stroke is observed when there is a sudden rupture or blockage of a blood vessel in the brain, leading to subsequent damage to the cells and tissues of central nervous system. [4] The clinical consequences of the stroke depend upon the affected area and extent of damaged tissue in the brain. Acute manifestations from the stroke, in addition to chronic musculoskeletal adaptation, contribute to subsequent weakness on the side contralateral to the brain injury. [5] Stroke often results in physical, psychological and social consequences that often greatly reduce quality of life and independence. Therefore, effective rehabilitation is essential to optimize functional recovery and to promote reintegration into society. Physiotherapy is an important part of the various rehabilitation approaches as it can restore motor function, improve mobility, increase balance, prevent secondary complications and promote independence.

The neuroplasticity principle, which refers to the potential of the brain to reorganize and create new neural connections after injury, forms the basis of physiotherapy intervention in stroke rehabilitation. Symptoms of a stroke happen suddenly. Each individual may present the symptoms of a stroke differently. [3] Symptoms may include: Having difficulty speaking or understanding. Problems with coordination or balance, A seizure or loss of consciousness, Numbness or weakness in legs, arms, or face. It usually happens on one side of the body, Difficulty with ambulation, Mouth drooping.

**Causes of stroke**

There are two main causes of stroke. An ischemic stroke is caused by a blocked artery in the brain. A hemorrhagic stroke is caused by the leaking or bursting of a blood vessel in the brain. Some people may have only a temporary disruption of blood flow to the brain, known as a transient ischemic attack (TIA). A TIA doesn't cause lasting symptoms.

To improve stroke patients' capacity to walk, researchers have looked into a variety of rehabilitation techniques. Post-stroke patients' gait performance has been successfully improved by high-intensity interval training (HIIT). [5. HIIT] is a training method that alternates periods of strong effort and recovery to enhance exercise intensity. [6] By raising capillary density to increase blood flow and mitochondrial density and efficiency, this exercise technique improves muscle oxidative capability. These elements help stroke patients have higher VO2 peaks, which enhance their gait. [7] It's crucial to remember that many stroke survivors may have impaired voluntary breathing, which may have an impact on how well they recover their gait. [8] Research has shown that aerobic treadmill training improves walking ability and aerobic capacity in chronic stroke patients. [9]

Enhancing muscle strength, balance, flexibility, and walking speed through a multicomponent exercise program that incorporates resistance, aerobic training, flexibility, and coordination has been shown to enhance patients' health outcomes. [10] For stroke patients, multicomponent exercise therapies are becoming a powerful rehabilitation approach. Research indicates that compared to a single set of exercises, structured exercise protocol therapy promotes a quicker recovery of gait capacity.

Early rehabilitation for stroke patients usually involves bed rest, which can result in lower limb weakness and muscle atrophy. Progressive activities must therefore be used throughout this early stage of recuperation. [15] training programs that concentrate on certain functional tasks that are patient-centered are used in a task-oriented approach. [16]. By increasing musculoskeletal and neurological activity, this training can improve the functional skills required for day-to-day functioning. Stroke patients' gait and muscle strength have improved as a result of high-intensity, circuit-based task-oriented training. [17].

Similarly, action observation training has improved gait ability by facilitating neural system activity. The research on the shared regions of the cortex during action observation training (inferior parietal lobule, inferior frontal gyrus and ventral premotor cortex) reveals that action observation training can result in motor cortex activation. [18,19] Besides the above-mentioned therapies, subsequent research have also focused on the efficacy of cycle training, balance training, and walking training to improve gait abilities in stroke patients.

This study set out to assess how structured training regimens and exercise therapies

affected stroke patients' gait performance.

**Need for study.**

Worldwide, stroke is the third leading cause of mortality and morbidity combined and second leading cause of death. It affects gait in the majority of the patients. The rehabilitative process aims to help the patient achieve a high level of functional independence. A multicomponent exercise intervention is emerging as a potent rehabilitative strategy of stroke patients but; **there is no specific validated protocol for the improvement of gait hence the need for validated structured exercise protocol is designed for gait.** The study will undertake to compare the effectiveness of structured exercise protocol (SEP-G) designed for the purpose and conventional exercises in the improvement of gait in stroke patients

In the subacute phase of stroke recovery neuronal plasticity allows for retraining of regenerating neurons this retraining is influenced by the repeated exercise pattern that are performed at a time. This happens due to phenomenon termed A-O whereby the action performed are memorized in the brain through mirror neuron system. (MNS)

Action-observation (AO) is a systematic observation by which the brain matches an observed action to its motor counterparts via mirror neuron system (MNS). It induces neuronal reorganization similar to that induced by physical training. Although, the subacute phase of stroke is a golden period of recovery and a stage of neuronal reorganization, the effect of AOE in subacute stroke has not been studied. In addition, motivation is a key element for engaging participants in AOE and is a contributor of continued choice, effort, and persistence to use paretic limbs

**Symptoms of stroke**

Hemiparesis -One-sided weakness. Patients may struggle to lift an arm or leg and exhibit facial drooping.
Hemiplegia -Complete paralysis of one side of the body, usually more severe than hemiparesis.
Facial droop-One corner of the lips may sag, making the patient unable to grin symmetrically.
Sudden onset. Stroke-related weakness manifests immediately, as opposed to gradual neurological illnesses.
Presentation from the opposite side-Weakness occurs on the opposite side of the body from the brain lesion (e.g., right brain injury resulting in left-sided weakness).

## Methodology

An Interventional, Prospective study was conducted at O. P. D & Ward in a tertiary care hospital on patients of MCA stroke. The simple random sampling was used to allocate the study participants. The study was started after formal approval from the Institutional Ethics Committee. All the study participants were selected according to the inclusion and exclusion criteria. The sample size was 80 patients of MCA stroke (40 per Group).

Inclusion criteria: unilateral MCA territory stroke, belonging to both gender Capable of understanding instructions, muscle weakness is assessed by the manual muscle testing scale, grades 0-3 degrees; written, informed, valid consent is available.

Exclusion Criteria: Patients with musculoskeletal pathological conditions that affect gait, who develop major illness, trauma, or stroke during the study; or with uncontrolled post-stroke seizures.

**Materials used**

Structured exercise protocol, Therapy balls (35,55 cm), Walkway, Coloured chalks, Stopwatch, Pillows, mat, Plinth weight cuff, Thera bands.

## Procedure

The present study was systematically conducted within the Physiotherapy Outpatient Department (OPD) and the Medicine Ward of a tertiary care hospital, ensuring a structured and professional environment for data collection. The duration of the study was two years, during which careful planning and execution were carried out to maintain consistency and reliability of the findings. Prior to the commencement of the research, formal approval was obtained from the Institutional Ethics Committee, thereby guaranteeing that all procedures adhered to established ethical standards and safeguarded the rights and well-being of the participants. The selection of participants was guided by a set of predefined inclusion and exclusion criteria that had been carefully formulated. These criteria helped in maintaining homogeneity within the study group and minimized potential confounding factors. By applying these standards, it was ensured that the participants represented the target population appropriately and that the results derived from the study would be both valid and generalizable. The structured approach, ethical clearance, and rigorous participant selection together contributed to the credibility of the research and laid a strong foundation.

To ensure the effectiveness and feasibility of the structured exercise protocol, a pilot study was undertaken. This preliminary study aimed to assess the protocol's practicality, safety, and initial impact on participants before proceeding to a full-scale research trial. The pilot study provided valuable insights into potential modifications needed to optimize the protocol for broader application. The pilot study was designed to evaluate the impact of SEP-G compared to conventional therapy (CT) on walking performance in stroke patients. A total of 20 patients were recruited and randomly assigned into two groups. Written informed consent was obtained from all subjects prior to participation. One group followed a structured exercise protocol (SEP-G, experimental group), while the other group performed conventional exercises (control group). The intervention lasted four weeks, with three supervised sessions conducted each week. The protocol was administered under the supervision of three senior physiotherapists. The hospital's standard set of conventional exercises was maintained for consistency. To minimize bias, patients were allocated to the therapists in consecutive order. Clinical histories and examination findings were documented. Each patient attended three supervised one-hour sessions per week, over a period of four weeks. The same procedure was implemented during the main study.

## Result

There was not a significant age difference amongst participants in both groups (p > 0.05).
Group A & Group B patients were gender matched.

**Table no. 1: Pre-Post Comparison of SEP-G.**

| Variable | Time point | Mean | | S.D. | P- value |
|---|---|---|---|---|---|
| **Structured exercises** | **StrideLength (inches)** | **Pre** | 33.30 | 4.00 | 8.35E-08* |
| | | **Post** | 52.80 | 4.18 | |
| | **StepLength (inches)** | **Pre** | 16.90 | 4.41 | 4.84E-06* |
| | | **Post** | 27.00 | 2.62 | |
| | **Cadence (steps/min)** | **Pre** | 64.20 | 10.46 | 7.74E-06* |
| | | **Post** | 91.40 | 5.23 | |
| | **Speed pre(meters/sec)** | **Pre** | 2.60 | 0.52 | 0.0005* |
| | | **Post** | 3.60 | 0.52 | |
| | **2 min walk test (meters)** | **Pre** | 100.60 | 11.16 | 0.00458 |
| | | **Post** | 118.20 | 15.50 | |

(* indicates P-value (< 0.001) is significant)
Significant improvement was noted in all five variables measured after SEP-G (all p < 0.01).

**Table no. 2: Pre-post comparison of Conventional Exercise (By using Paired t-test)**

| | Variable | Time Point | Mean | S.D. | P-value |
|---|---|---|---|---|---|
| **Conventional Exercises** | **Stride Length (inches)** | **Pre** | 32.90 | 5.17 | 0.0006* |
| | | **Post** | 44.20 | 4.96 | |
| | **Step Length** | **Pre** | 18.50 | 4.14 | 0.0001* |
| | | **Post** | 27.30 | 2.98 | |
| | **Cadence (steps/min)** | **Pre** | 64.70 | 11.37 | 4.85E-05* |
| | | **Post** | 89.30 | 3.97 | |
| | **Speed Pre (meters/sec)** | **Pre** | 2.50 | 0.53 | 0.0054* |
| | | **Post** | 3.30 | 0.48 | |
| | **2 min walk test (meters)** | **Pre** | 101.90 | 6.89 | 0.0023* |
| | | **Post** | 122.50 | 17.04 | |

(* indicates P-value (< 0.001) is significant)

The table demonstrates a significant improvement in all gait parameters and functional walking capacity following conventional exercise therapy. Overall, these findings indicate that conventional exercise therapy produced statistically significant improvements in gait performance and functional mobility among the study participants.

**Table no. 3: Improvement in Spatiotemporal variables**

| Variables | Difference in Pre- & Post in Group A | Difference in Pre- and Post in Group B | P value |
|---|---|---|---|
| **Stride length (inches)** | 19.5 | 11.3 | 0.004* |
| **Step length** | 10.1 | 0.15 | 0.147 |
| **Cadence (steps/min)** | 27.2 | 24.6 | 0.132 |

| Speed Pre(meters/sec) | 1 | 0.8 | 0.254 |
|---|---|---|---|
| 2minwalktest(meters) | 18.4 | 22.6 | 0.281 |

(* indicates P-value (< 0.001) is significant)

Table 3 compares the improvement in spatiotemporal gait variables between Group A and Group B following the intervention. Group A demonstrated a significantly greater improvement in stride length, with a mean increase of 19.5 inches compared to 11.3 inches in Group B (p = 0.004), indicating superior effectiveness of the intervention in enhancing stride length. Although Group A also showed greater improvement in step length (10.1 vs. 0.15), the difference between the groups was not statistically significant (p = 0.147). Similarly, improvements in cadence (27.2 vs. 24.6 steps/min; p = 0.132), walking speed (1.0 vs. 0.8 m/s; p = 0.254), and 2-minute walk test distance (18.4 vs. 22.6 meters; p = 0.281) did not differ significantly between the two groups. Overall, the findings suggest that while both interventions improved spatiotemporal gait parameters, Group A achieved a significantly greater improvement only in stride length, whereas the improvements in the remaining variables were comparable between the two groups.

**Table no. 4: Group Comparison (By using Unpaired t test)**

| Variable | Group | Mean | S.D. | P-value |
|---|---|---|---|---|
| **Stride Length (inches)** | Structured Exercise | 52.80 | 4.185 | 0.0003* |
| | Conventional Exercises | 44.20 | 4.962 | |
| **Step Length** | Structured Exercise | 27.00 | 2.625 | 0.4070 |
| | Conventional Exercises | 27.30 | 2.983 | |
| **Cadence (steps/min)** | Structured Exercise | 91.40 | 5.232 | 0.1628 |
| | Conventional Exercises | 89.30 | 3.974 | |
| **Speed Pre (meters/sec)** | Structured Exercise | 3.60 | 0.516 | 0.0982 |
| | Conventional Exercises | 3.30 | 0.483 | |
| **2 min walk test (meters)** | Structured Exercise | 118.20 | 15.498 | 0.2811 |
| | Conventional Exercises | 122.50 | 17.038 | |

(* indicates P-value (<0.001) is significant)

Table 4 presents the post-intervention comparison of spatiotemporal gait variables between the Structured Exercise group and the Conventional Exercise group using the unpaired t-test. The Structured Exercise group demonstrated a significantly greater stride length (52.80 ± 4.19 inches) compared to the Conventional Exercise group (44.20 ± 4.96 inches), and this difference was statistically significant (p = 0.0003). However, there were no statistically significant differences between the two groups in step length (27.00 ± 2.63 vs. 27.30 ± 2.98; p = 0.4070), cadence (91.40 ± 5.23 vs. 89.30 ± 3.97 steps/min; p = 0.1628), walking speed (3.60 ± 0.52 vs. 3.30 ± 0.48 m/s; p = 0.0982), or 2-minute walk test distance (118.20 ± 15.50 vs. 122.50 ± 17.04 meters; p = 0.2811). Overall, the findings indicate that structured exercise was significantly more effective than conventional exercise in improving stride length, while both interventions produced comparable outcomes for step length, cadence, walking speed, and functional walking capacity.

**Main Study**

**Age:** There was not significant age difference amongst participants in both groups

**Gender:**

| Gender | Structured Exercise | Conventional Exercise |
|---|---|---|
| | **Frequency (%)** | **Frequency (%)** |
| Female | 18(45) | 18(45) |
| Male | 22(55) | 22(55) |
| **Total** | **40(100)** | **40(100)** |

**Group A & Group B patients were gender-matched.**

| Parameters | Structured Exercises (Mean ± SD) | | | Conventional Exercises (Mean ± SD) | | |
|---|---|---|---|---|---|---|
| | **Pre** | **Post** | **p-value** | **Pre** | **Post** | **p-value** |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Stride Length (inches)** | 45.13 ± 12.70 | 50.30 ± 6.11 | 0.036* | 33.30 ± 4.85 | 50.95 ± 6.41 | <0.001 * |
| **Step Length** | 19.55 ± 4.84 | 31.8 ± 6.27 | <0.001 * | 38.8 ± 15.61 | 30.48 ± 6.13 | 0.007* |
| **Cadence (steps/min)** | 67.3 ± 8.71 | 89.9 ± 4.05 | <0.001 * | 59.65 ± 9.45 | 82.9 ± 6.55 | <0.001 * |
| **Speed (meters/sec)** | 2.53 ± 0.55 | 3.55 ± 0.50 | <0.001 * | 2.77 ± 0.80 | 2.93 ± 0.69 | 0.371 |
| **2 Min Walk Test (meters)** | 96.18 ± 9.72 | 133.00 ± 21.17 | <0.001 * | 116.58 ± 15.61 | 123.73 ± 15.49 | 0.003* |

In the structured exercise group, all the parameters stride length, step length, cadence, speed, and 2-minute walk test distance showed significant improvement after the intervention. This suggests that the structured program had a broader positive impact. In the conventional exercise group, there was a significant improvement in stride length, step length, cadence (steps per minute), and distance covered in the 2-minute walk test.

| Parameters | Structured Exercises (Mean ± SD) | Conventional Exercises (Mean ± SD) | p-value |
|---|---|---|---|
| **Stride Length (inches)** | 50.30 ± 6.11 | 50.95 ± 6.41 | 0.644 |
| **Step Length** | 31.80 ± 6.27 | 30.48 ± 6.13 | 0.307 |
| **Cadence (steps/min)** | 89.90 ± 4.05 | 82.90 ± 6.55 | <0.001* |
| **Speed (meters/sec)** | 3.55 ± 0.50 | 2.93 ± 0.69 | <0.001* |
| **2 Min Walk Test (meters)** | 133.00 ± 21.17 | 123.73 ± 15.50 | 0.081 |

When comparing the post-exercise results between the two groups, the structured exercise group showed significantly better performance in cadence and speed. For stride length, step length, and 2-minute walk distance, the structured group had slightly better results, but the differences were not statistically significant.

## Discussion

Many studies were carried out to find out best protocol for managing gait deficits. Those studies also showed significant changes in their outcome with respective exercises.

The Structured exercise protocol (SEP-G) is designed to offer a novel combination of exercises that will compare equally or favorably to the conventional exercises used for rehabilitation of stroke patients.

The patients splatted into two groups

**Group A – SEP-G designed structured exercise protocol (experimental group 40)**
**Group B - CT (conventional exercises 40)**

This study undertook to validate designed structured exercise protocol and to ascertain the user experience in terms of feasibility and time involved in implementation. The pilot study aimed to compare the effectiveness of SEP-G and CT in the walking performance of stroke patients. The pilot study was conducted with 20 subjects. Subjects were divided in 2 groups. Written, informed valid consent was taken. The patients were split into two groups which received designed structured exercise protocol (experimental group) and conventional exercises(controlgroup). The intervention was carried out for 4 weeks with 3 supervised sessions per week. In these 20 participants were recruited and were divided in 2 groups.

Group-wise comparison (Unpaired t test) Group A Showed Higher mean in cadence and speed (p> 0.05) Greater stride length (p= 0.0003) A significant difference was observed in both groups regarding spatiotemporal variables, (Stride length and higher mean in Speed, and Cadence) which suggests that SEP-G facilitates more efficiently gait parameters in the stroke patients as compared to CT. The limitations of the study were the small sample size. A combined study of SEP-G and CT with a large sample size including all variables and measures became the further recommendation of the study.

Post intervention of the main study results showed that patients receiving SEP-G had significant improvement in spatiotemporal variables. The researcher was unable to find any study that focused on the components of the SEP-G protocol, to enable direct comparison. The improvement in the spatiotemporal variables can be explained on the basis of neuronal plasticity following the brain lesion. It is suggested that complex organization provides the foundation for functional plasticity in the motor cortex. Cortical representation reflects changes associated with skill development which is stimulated by repetitive training and practice. [6] Muscle weakness in stroke patients can result in immobilization or reduced physical activity. The strength of hip flexor muscles, knee extensor muscle, and ankle plantar flexor muscle are the main factors for comfortable or fast walking speed in stroke patients. [7] In designed structured exercise protocol training real life activities were followed whereas in conventional training a simple repeated exercise of movement was followed. In SEP-G intersegmental coordination was taken into consideration which could contribute to improvement in walking performance. On contrary in CT group intersegmental coordination was not taken into consideration. SEP-G added specificity and variability to practice. Hence, structured exercise protocol training was found to improve the walking performance because of task specificity of motor relearning programme which assisted in improving motor control of lower limb and motor learning in walking.[8]A meta-analysis of Wist S. et al. suggested that appropriately targeted progressive resistant training is effective in improving muscle strength.[9]Similarly, in this study Structured exercise protocol(SEP-G) training significantly improved spatial and temporal variables of the patient The reason for these results may be structured exercise protocol training which improved passive viscoelastic properties of muscle and tendons which could influence hypertonia.[5] In this study significant difference was observed in the pre and post-treatment values of both the groups. Structured exercise protocol (SEP-G) training showed significant improvement in the outcome measures suggesting that it facilitates the walking performances. This was confirmed using statistical analysis by using 'Paired t-test' for within group comparison and 'Unpaired t test' for between the group comparisons. Present study, shows that after intervention there was significant improvement in the outcome with structured exercise protocol (SEP-G) training as SEP-G provides specificity and variability in practice of the exercise. Patients were given chance to practice in variability of contexts. Although skill performance may be initially delayed, it might have helped in improved retention of skill. Then acquired skill can be applied more easily to other novel environmental situations in real life activity. However, continuous practice carried out in conventional training might have slight context and learner had only inadequate number of solutions. [9,10]

Statistical analysis was done by using 'Paired t test' for within group comparison and 'unpaired t test' for between group comparison. In the present study it was found that after interventions there was significant improvement in the outcomes with structured exercise protocol group. It is effective in facilitating normal gait parameters.

In the structured exercise group, all the parameters stride length, step length, cadence, speed, and 2-minute walk test distance showed significant improvement after the intervention. This suggests that the structured program had a broader positive impact. In the conventional exercise group, there was a significant improvement in stride length, step length, cadence (steps per minute), and distance covered in the 2-minute walk test.

**Withen Group Comparison**
(Spatial Variables)-
Stride Length (inches) – SEP-G value= p value= 0.036
CT value= 0.001
Step Length – SEP-G value= p value= 0.001
CT value= 0.007
Cadence (steps/min) – SEP-G value= p value= 0.001
CT value= 0.001
Speed (meters/sec) – SEP-G value= p value= 0.001
CT value= 0.371
2 Min Walk Test (meters) – SEP-G value= p value=0.001
CT value= 0.003

Between Group Comparison When comparing the post-exercise results between the two groups, the structured exercise group showed significantly better performance in cadence and speed. For stride length, step length, and 2-minute walk distance, the structured group had slightly better results, but the differences were not statistically significant.
Stride length post-test p value = 0.644
Step length post-test value= 0.307

Cadence post-test value= 0.001
speed post-test value= 0.001
2 min walk test post-test value= 0.081
This suggest that SEP-G is effective in facilitating normal gait parameters.
SEP-G might have helped the patients to have better motor planning and motor relearning. this accounts to better improvement in structured in structured exercise protocol training as compared to conventional training.

## Structured exercise protocol (sep-g)

The exercise protocol is derived from the exercises proposed by Gresham GE et al. and Yang YR et al. using the materials. In [10], the Brunstorm approach [11] and the Bobath approach in this training, major emphasis is given on exercises in lying, sitting, and standing positions. Here intersegmental coordination was incorporated to assess the walking performance.
In the subacute phase of stroke recovery, **NEURONAL PLASTICITY** allows for retraining of regenerating neurons. This retraining is influenced by the repeated exercise patterns that are performed at a time.

**STRUCTURED EXERCISE PROTOCOL**

| | |
|---|---|
| Physiotherapy Treatment in Stage I and Stage II | 1.Bed Mobility Exercise (Turning)<br>Duration of training - 1st week 10 reps, 2 times a day |
| | 2. Exercise to develop hip control on paralysed side by Raimistes adduction phenomenon<br>Duration of training- 2ndweek 10 reps, 2 times a day |
| | 3. Kinesiotaping for hemiplegic shoulder pain<br>Duration – 2nd and 3 rd week<br>Tape should be kept for 2 hours Daily. |
| | 4.Prescibing Shoulder support to prevent hemiplegic shoulder pain and subluxation in stroke<br>Duration – 4th week should be worn during exercising, transfers and positioning. |
| | 5.Exercise variation – To gain mid range of motion in paretic upper limb<br>Progression – 5th and 6th week 10 reps, 2 times a day |
| | 6. Local facilitatory technique – Tapping Rubbing<br>Duration 7th ,8th and 9th week 5 times twice a day |
| | 7.Exercises to generate flexor activity on weaker side on phenomenon on imitation synkinesis<br>Duration – 10th 11th week 5 reps 2 times a day |
| | 8. Functional task oriented exercises from isometric to eccentric contraction<br>Duration – 10th, 11 th week 10 reps, 2 time a day |

| | |
|---|---|
| Physiotherapy Treatment in Stage III, IV and V | 1. Passive manipulation techniques with grasping exercises and cutaneous stimulation<br>Duration – 12th week 15 reps once a day |
| | 2. Hand manipulation technique for spasticity – Free hand swatting movements distally directed over PIP and DIP joints<br>Duration- 13th 14 th week 5 times once in a day |
| | 3. Facilitation exercise for finger extension by flexing shoulder to 90 degree (Souques finger phenomenon)<br>Duration – 14 th week 5 times once a day |
| | 4. To decrease synergy – Task oriented activites<br>Duration – 15th week 10 reps twice a day |
| | 5. Introducing a new movement outside the synergy<br>Duration – 16th week 10 reps twice a day |
| | 6. Matrix Rhythm therapy for spastic muscles<br>Duration – 16 th week 1hour<br>17 th week 1 hour |

| | |
|---|---|
| Physiotherapy Treatment in Stage VI and VII | 1. Gait training exercises for stroke re ambulatory exercises<br>a. Closed kinematic chain exercises with Bilateral knee bending and straightening exercises<br>b. Closed kinematic chain exercises with alternate knee bending and straightening exercises<br><br>(Duration: 17th and 18th week<br>15 reps twice a day) |
| | 2. Modified kinematic chain exercises<br>a. Normal leg moves in contact with floor so more weight is brought on paralytic leg<br>b. Normal leg moves on Unstable surface like ball rather than floor<br><br>(Duration: 18th week, 10 reps twice a day) |

| | |
|---|---|
| | 3. Weight bearing exercises on paretic side with floor mat on normal side.<br>Duration: 19th week 15 reps twice a day |
| | 4. Mini squate exercise with peg board<br>Duration: 20th and 21st week 15 reps twice a day |
| | 5. Anterior pelvic rotation and protraction exercises with peg board<br>Duration 22 nd and 24 th week 15 reps twice a day |

**Conventional Physiotherapy training**

| | |
|---|---|
| Physiotherapy exercises in stage 1 And II | 1.Positioning in supine, side lying, prone<br>Duration 1st and 2nd week 2 hours on each position |
| | 2.Moist pack and Infra red rays for hemiplegic shoulder pain<br>Duration 3 rd and 4th week 10 min each session twice a day |
| | 3.Passive movements for paretic limb<br>Duration 3rd, 4th, and 5th week 15 reps twice a day |
| | 4. Chest physiotherapy- Percussions and vibrations<br>Duration- 3rd , 4th ,5th week 30 to 40 percussions and vibration at the end of expiration |
| | 5.Uses of splints<br>Duration 5th and 6th week<br>Alternate 2 hrs to be wore |
| | 6.Functional electrical stimulation for paretic muscles<br>Duration 7th to 9th week 90 contractions in 3 sets |
| | 7.Arrangement of patients room |
| | 8.Facilitatory exercises for hypotonia(Light moving touch and fast brushing)<br>Duration 10th week 5stroking on each dermatome |

| | |
|---|---|
| Physiotherapy treatment in stage III,IV,V | 1.Stretching exercises – sustain slow stretching for 20 sec to be given<br>Duration 16th, 17 th week 2times daily |
| | 2.Deep massage for paretic side (efflurage, Kneading)<br>Duration 18th week 15 min each hemiparetic part |
| | 3. Prolonged pressure / Tendon pressure<br>On hemiparetic side Duration ( 18th week 2 min each part) |
| | 4.Ice massage on paretic side<br>Duration 19th week 10 min on each part |
| | 5.Use of splints<br>Duration 2 hours twice a day |

| | |
|---|---|
| Conventional exercise training in stage VI and VII | 1. Berg balance exercises in sitting and standing<br>Duration 21 st week 5 min each exs twice a day |
| | 2. Exercises on tilt table<br>Duration 22 nd week half hour during one session twice a day |
| | 3. Strengthening exercises with therabands, weight cuff<br>Duration 23rd week 15 reps twice a week |
| | 4. Parallel bar exercises in standing and walking<br>Duration 24th week 15 reps twice a day |
| | 5.Traning exercises for normal and free ambulation without any support<br>Duration 24th week 15 reps twice a day |

## Conclusion

The study demonstrated that SEP-G and CT were highly successful in enhancing stroke patients' gait performance. The SEP-G protocol has been associated with greater improvements in cadence and speed as well as better gait performance compared to conventional exercises. But when the intended SEP-G and CT were compared, it was found that the former was more successful at improving gait performance. This suggests that a structured exercise protocol could be a valuable addition to the rehabilitation process for stroke patients.

SEP-G produced **significant improvements in cadence and speed**, which are critical determinants of functional independence, while also enhancing stride length, step length, and walking endurance. These findings highlight the importance of **task-specific, variable, and context-driven training** that incorporates intersegmental coordination and real-life activities.

Overall, SEP-G offers a **clinically feasible, cost-effective, and patient-centered rehabilitation approach** that can be implemented in routine practice without the need for advanced equipment. It bridges the gap between laboratory-based improvements and functional independence in daily life, making it a valuable addition to stroke rehabilitation protocols.

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