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Original Article

THE EFFECT OF METRONOME AND CORE STRENGTHENING EXCERCISE TO IMPROVE DYNAMIC BALANCE AND GAIT IN STROKE PATIENTS

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ABSTRACT

Objective: Stroke is a predominant cause of adult disability and ranks as the third leading cause of mortality in the Western Hemisphere. Approximately half of stroke survivors endure severe long-term disabilities, often characterized by balance impairments that hinder mobility, daily activities, and increase fall risk. Consequently, restoring mobility through effective gait training is a crucial rehabilitation goal. Recent studies have investigated the utility of auditory cues, such as metronome timing, to enhance hemiparetic gait, while core strengthening has gained recognition for its role in stabilizing the spine and body during movement.

Methods: This study involved 40 participants divided into two groups. Group a, comprising 20 subjects, participated in a regimen of core strengthening exercises designed to enhance dynamic balance and gait, supplemented by general dynamic balance and gait training, and metronome-based balance and gait training. Group B, also consisting of 20 subjects, engaged solely in core strengthening exercises. The study was conducted over an eight-week period with assessments on days 1, 15, 40, and 60. Outcome measures included the tinetti gait and balance score and the Timed Up and Go (TUG) test.

Results: The analysis demonstrated significant improvements in both balance and gait among stroke patients in Group A, as evidenced by higher Tinetti scores and lower TUG times (p = 0.00). These results indicate that the integration of metronome training with core strengthening exercises yields superior outcomes compared to core strengthening exercises alone.

Conclusion: The study concludes that combining metronome training with core strengthening exercises significantly enhances balance and gait in stroke patients. This combined approach proves to be more effective than core strengthening alone, offering a robust strategy for improving gait and balance in stroke rehabilitation.

Keywords: Stroke, Metronome, Core strengthening, Tinetti, TUG

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INTRODUCTION

The World Health Organization defines a stroke as "a syndrome of rapidly developing clinical signs of focal (or global) disturbance of cerebral function, with symptoms lasting 24 h or longer or leading to death, with no apparent cause other than of vascular origin [1]. This definition encompasses subarachnoid hemorrhage but excludes subdural hemorrhage, transient ischemic attack (TIA), or hemorrhage or infarction resulting from a tumor or infection. Silent cerebral infarcts are also not included in this definition. Studies predominantly based on symptomatic stroke data may underestimate the true burden of cerebrovascular disease [2].

Modifiable risk factors for stroke include smoking, hypertension, and high cholesterol. A stroke, characterized by the sudden loss of brain function due to interrupted blood supply, can result from either hemorrhage or ischemia caused by a blockage [3]. Post-stroke deficits can affect motor, sensory, perceptual, or cognitive functions, hindering rehabilitation potential and causing various disabilities. Stroke survivors often struggle with asymmetric posture, abnormal body balance, and impaired weight transfer, complicating their ability to maintain balance and postural control while upright [4]. Additionally, asymmetric movement affects the ability to stand straight, disrupts midline and spatial orientation, and interferes with proper vertebral alignment, trunk rotation, trunk-to-extremity selective movement, anterior-posterior pelvic tilt during weight transfer, and both protective and equilibrium reactions [5].

Previous research highlights the importance of trunk control in ensuring stable walking and reducing the incidence of falls in stroke patients. Stroke remains the leading cause of adult disability and the third most common cause of death in the Western Hemisphere. Approximately 50% of stroke survivors suffer from significant long-term disabilities. Balance issues, prevalent after a stroke, are associated with poor recovery in mobility and activities of daily living (ADL), as well as an increased risk of falling [6].

The terms "postural control," "posture," "equilibrium," "balance," and "balance reactions" are often used interchangeably without universally accepted definitions or consistent application. This lack of clarity hampers efforts to generalize findings or draw inferences from the literature. Most studies have focused on balance impairments, such as postural sway and weight distribution, rather than balance disabilities-specific tasks a person can perform while maintaining upright posture, such as static or dynamic sitting or standing balance. Regaining gait mobility is a primary goal of stroke rehabilitation. Despite extensive research, there remains a gap in comprehensive knowledge regarding balance issues in stroke patients. Various treatment modalities have been proposed to facilitate better walking in stroke patients [7].

Recent research indicates that over 30 million people worldwide have survived strokes. Despite advancements in medical and rehabilitation sciences, many stroke survivors continue to experience residual walking disabilities, impacting their quality of life and ability to engage in daily activities. Walking difficulties can limit social interactions, leading to housebound and socially isolated individuals. Enhancing community ambulation abilities is a key objective of rehabilitation. Hemiparetic gait is characterized by asymmetrical stepping, increased unpredictability, and reduced walking speed. Understanding and addressing these gait deficiencies is crucial for improving the independence and quality of life of stroke patients [8].

Metronome and stroke rehabilitation

Stroke patients with balance and gait disorders often exhibit reduced physical function. Improving muscle strength and balance is essential for functional recovery and the performance of activities of daily living (ADLs). In the past two decades, research has begun to elucidate the neurological mechanisms underlying music's impact on the human brain. Rhythm, a fundamental component of musical "language structure," has been a central focus of these studies.

MATERIALS AND METHODS

Participants

A total of 40 subjects will be randomly assigned to two groups, each comprising both male and female participants. Group A will undergo metronome dynamic balance and gait training combined with core strengthening exercises and general dynamic balance and gait training. Group B will participate in core strengthening exercises and general dynamic balance and gait training only. The study will compare the outcomes of both groups to determine which yields more positive results.

Study design

This study will be conducted over an eight-week period, with data collection occurring on days 1, 30, 60, and 90. The primary outcome measures will be the tinetti gait and balance score and the Timed Up and Go Test.

Inclusion criteria

Subjects must meet the following criteria to participate:

- Age: 45-60 y
- Only right hemiplegic patients
- Six months post-stroke
- Walking disability but retained ability to stand and transfer
- Spasticity grade: 2 (modified Ashworth scale)
- Extension synergy type

Exclusion criteria

Potential participants will be excluded if they have:

- Cognitive impairments preventing understanding of the task
- Hearing impairments reducing the ability to hear the metronome
- Cardiovascular or cardiopulmonary problems
- Orthopedic conditions
- Use of walking aids

Data collection tools

- Client Information Sheet
- Client Assessment Sheet
- Consent Form
- General Instruction Sheet
- Assessment Tools/Outcome Measures: Timed Up and Go Test, Tinetti Test
- Data Collection Sheet
- Metronome

Procedure

Group A: Metronome training with core strengthening exercises and general dynamic balance and gait training exercises

Core strengthening exercises

- **Bridging:** Patients lie on their back with feet flat on the floor and knees bent, then raise their hips off the floor.
- **Knee rolling:** Patients lie on their back with hands by their sides, feet flat on the ground, and knees bent. They roll their hips, pushing their knees to the left, right, and back to the center.
- **Single leg drop-outs:** Patients lie on the floor with hips and feet flat, knees bent. They drop one knee to the side without lifting the pelvis and then draw it back.
- **Single leg bridging:** Patients lie on the exercise mat with one leg flat on the floor, knee bent, and the other leg on a fitness ball. They lift their pelvis off the mat using core muscles and then slowly lower it back down.
- **Four-point kneeling:** Patients assume a crawling position, lift one leg while raising the opposite arm by contracting the pelvic floor, and then return to the starting position.
- **General dynamic balance and gait training exercises**
- **Heel raises (holding on):** Patients hold onto a sturdy chair or countertop, rise onto their tiptoes, and lower back to the floor.
- **Side stepping (holding on):** Patients hold onto a counter or ledge, step sideways crossing one leg in front of the other, and then reverse the motion.
- **Single leg standing:** Patients raise one leg until balanced on the other, hold for ten counts, and then switch legs.
- **Backwards walking:** Patients walk backwards in a room free from obstacles, using slow movements to avoid falls.
- **Parallel bar walking:** Patients walk along parallel bars to maintain balance.

Timed up and go test: On the command "go," patients walk 3 meters at a comfortable and safe pace, turn, and walk back to the starting point.

Group B: Core strengthening exercises and general dynamic balance and gait training exercises

Subjects in Group B will perform the same core strengthening exercises and general dynamic balance and gait training exercises as group a but without the metronome training. The outcomes of both groups will be compared to determine which group shows more positive results.

RESULTS

The T-test was employed for data analysis in this study. A total of 40 participants, both male and female, were recruited. Descriptive analysis was used to evaluate the functional efficacy of pre-and post-treatment interventions for individuals with chronic stroke. Group A, which received metronome training combined with core strengthening exercises, demonstrated a significant improvement.

The data analysis utilized the T-test. A total of 40 participants, both male and female, were included in this study. The functional efficacy of the interventions before and after treatment for individuals with chronic stroke was evaluated using descriptive analysis. Notably, Group A, which underwent metronome training combined with core strengthening exercises, exhibited significant improvements.

For the Tinetti test, Group A (metronome training with core strengthening exercises) demonstrated a notable mean score improvement of 22.3 with a standard deviation of 1.04. In contrast, Group B (core strengthening exercises only) showed a mean score of 18.35 with a standard deviation of 1.43.

In the Timed Up and Go (TUG) test, Group A achieved a mean score of 11.45 with a standard deviation of 0.69, whereas Group B recorded a mean score of 12.40 with a standard deviation of 0.81.

The paired differences and T-test results for the Tinetti test indicated a significant difference between the groups, with a mean difference of 3.95 ($p<.0001$). This suggests that the metronome training combined with core strengthening exercises provided substantial benefits over core strengthening exercises alone.

Similarly, for the TUG test, the results showed a mean difference of 0.95 ($p<.0001$), again favoring the combination of metronome training and core strengthening exercises. This significant improvement highlights the effectiveness of incorporating metronome training in the rehabilitation of stroke patients, enhancing both balance and gait compared to core strengthening exercises alone.

DISCUSSION

The findings of the current study indicate that stroke patients can significantly benefit from metronome gait training. Although Group B, which underwent traditional physiotherapy, showed improvement, Group A exhibited greater progress in core strength and gait training [10].

The study demonstrated that both core strengthening and metronome training effectively enhance balance and gait in stroke patients. The results supported the hypothesis that stroke survivors benefit from the combined approach of metronome training and core strengthening. This conclusion is further corroborated by the results of the Timed Up and Go (TUG) test and the Tinetti test, which both showed substantial improvements [11].

In both intervention groups, there was a significant difference in TUG scores between pre-and post-treatment assessments. Statistically significant differences ($p<0.05$) were observed in the means for both TUG and Tinetti tests across the groups [12]. The T-test results for Group A were particularly noteworthy, indicating significant improvements in both TUG and Tinetti scores. These findings suggest that metronome training, when combined with core strengthening exercises, offers a superior method for improving balance and gait in stroke patients compared to traditional physiotherapy alone.

CONCLUSION

This study demonstrates a significant improvement in the Timed Up and Go (TUG) test and the Tinetti test for Group A, which received metronome training combined with core strengthening exercises, after a stroke. The results showed a substantial increase in the mean scores for Group A, particularly in the Tinetti test, along with a marked decrease in the TUG test scores. The statistically significant p-values reinforce the effectiveness of this combined approach. These findings underscore the enhanced rehabilitation outcomes achieved through the integration of core strengthening exercises and metronome training, leading to improved balance and gait in stroke patients.

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AUTHORS CONTRIBUTIONS

All the authors have contributed equally

CONFLICTS OF INTERESTS

Declared none

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