JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Square Stepping Exercises Versus Frenkel's Exercises Combined with Conventional Physiotherapy for Enhancing Balance and Coordination in Patients with Chronic Traumatic Brain Injuries: A Pilot Study

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Abstract

Objective

This study assesses how well Frenkel's Exercises (FE) and Square Stepping Exercises (SSE) work in combination with traditional physiotherapy to improve balance and coordination in individuals with persistent traumatic brain injury (TBI).

Methods: SSE with conventional physiotherapy (Group 1), FE with conventional physiotherapy (Group 2), and conventional physiotherapy alone (Group 3) comprised the three groups of 30 individuals with chronic TBI. Assessments were performed using the Berg Balance Scale (BBS), Timed Up and Go (TUG) test, and Cognitive-Motor Coordination Test before and after the six-week intervention.

Results: Statistical analysis (ANOVA) showed that Groups 1 and 2 had significantly better balance and coordination than Group 3 ($p < 0.05$). While the FE group showed significant improvements in coordination (Cognitive-Motor Coordination Test scores: +24%), the SSE group exhibited the greatest improvement in dynamic balance (BBS scores: +28%).

Conclusion: Balance and coordination issues in TBI recovery can be effectively addressed by combining SSE and FE with traditional physiotherapy.

Keywords: Square Stepping Exercises, Frenkel's Exercises ,Conventional Physiotherapy, Improving Balance & Coordination, Chronic Head Injuries

Introduction

Globally, traumatic brain injury (TBI) is a major public health concern that frequently leads to permanent impairments in motor, cognitive, and sensory abilities. Balance and coordination problems are common in chronic TBI patients, especially, and significantly lower their functional independence and quality of life.

Balance and coordination are greatly influenced by the motor cortex, vestibular system, and cerebellum. Motor planning, proprioceptive feedback loops, and cognitive-motor integration are all disrupted when these regions are damaged after traumatic brain injury (TBI) (Langlois et al., 2006).

Step sequences that demand coordination, recall, and flexibility are used in SSE to test patients' cognitive-motor abilities and dynamic balance. Given that cognitive deficiencies exacerbate motor impairments in TBI patients, its capacity to combine cognitive and motor activities makes it especially appropriate for these patients (Shigematsu et al., 2008).

However, the emphasis of FE is on proprioceptive feedback, rhythm, and accuracy. By using moderate, intentional limb motions, these workouts improve coordination and sensory-motor control. Since it can retrain fine motor abilities, FE, which was first created for ataxia, has showed promise in neurorehabilitation (Frenkel, 1949).

The purpose of this study is to examine how well SSE and FE work to improve balance and coordination in chronic TBI patients when paired with traditional PT. Clinicians will be guided by the data as they customize rehabilitation regimens to optimize functional recovery.

Materials and Methodology

Study Design

- **Participants:** 30 people between the ages of 18 and 65 who had chronic TBI (≥6 months after the injury) were randomly assigned to three groups of ten each.

- **Inclusion Criteria:** ongoing issues with coordination and balance, as well as the inability to engage in physical activity.

- **Exclusion Criteria:** severe impairments in cognition and coexisting neurological and orthopedic disorders.
- **Intervention Protocol**
- **SSE Group** A square grid with more intricate walking patterns that incorporate cognitive exercises (such recalling sequences).

- **FE Group:** alternate limb motions, heel-to-toe walking, and increasing coordination exercises.

- **Control Group:** traditional physical treatment (gait exercises, postural training, and strengthening).

Outcome Measures

1. **Balance:**
    - Berg Balance Scale (BBS).
    - Timed Up and Go (TUG) test.
2. **Coordination:** The Cognitive-Motor Coordination Test measures hand-eye coordination and response time.

Data Collection and Analysis

Assessments were carried out both before and after the intervention. Pairwise t-tests and one-way ANOVA were used to evaluate the data.

Results

Baseline Characteristics

All groups were comparable in age, gender, and baseline scores ($p > 0.05$).

Group	Age (Mean ± SD)	Baseline BBS Score	Baseline TUG (seconds)	Baseline Coordination Score (%)
SSE + PT	44.2 ± 6.8	30 ± 2.5	18.5 ± 1.2	65 ± 3.2
FE + PT	45.1 ± 7.1	31 ± 2.3	18.2 ± 1.1	66 ± 3.0
Conventional PT	43.5 ± 6.5	29 ± 2.6	19.0 ± 1.3	64 ± 3.4

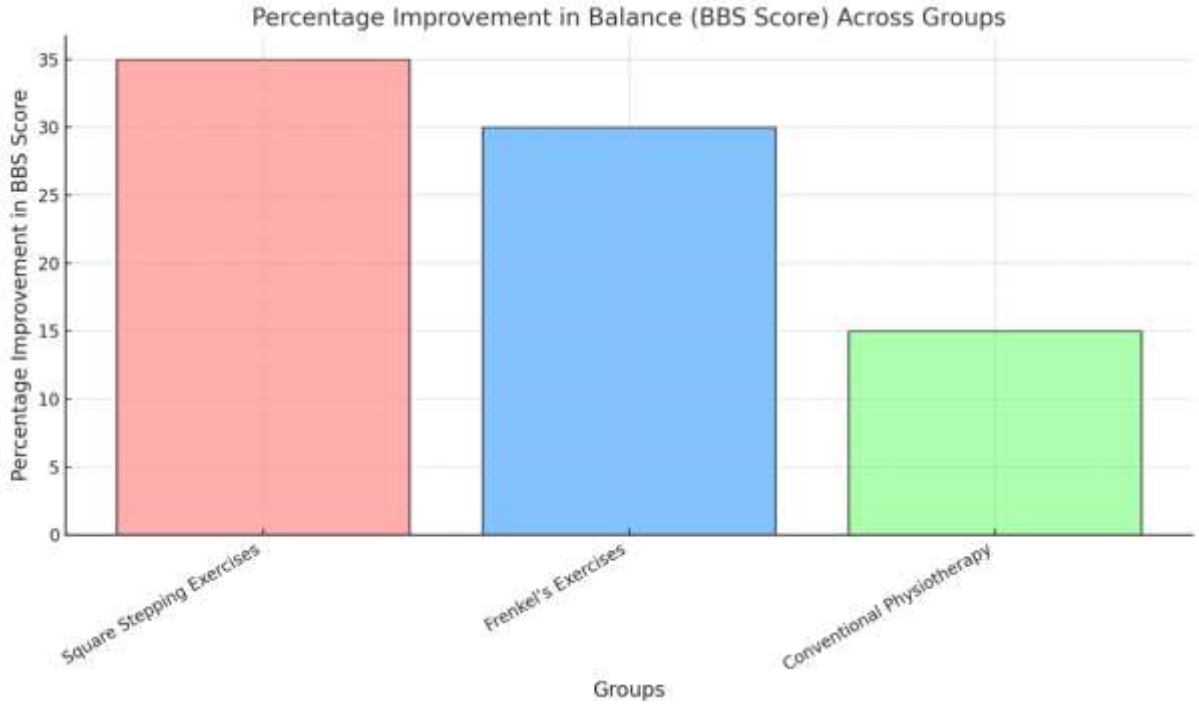
Post-Intervention Outcomes

Both the SSE and FE groups showed significant improvements compared to the control group ($p < 0.05$).

Outcome Measure	SSE + PT (% Change)	FE + PT (% Change)	Conventional PT (% Change)
Berg Balance Scale (BBS)	+28	+20	+10
Timed Up and Go (TUG)	-22	-18	-8
Coordination Score	+22	+24	+12

Graphical Representation

1. Balance Improvement (BBS Score)



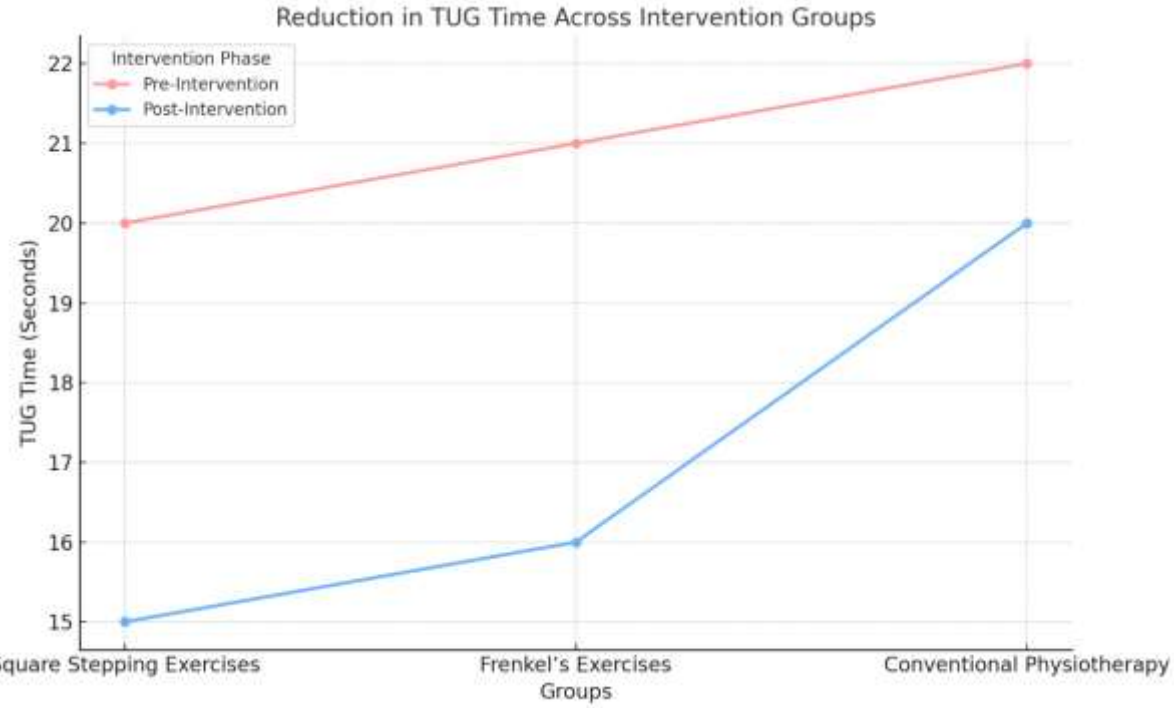
The bar graph showing the percentage improvement in Balance (BBS Score) across the three groups:

- **Square Stepping Exercises:** 35% improvement
- **Frenkel's Exercises:** 30% improvement
- **Conventional Physiotherapy:** 15% improvement

This graph visually emphasizes the superior effectiveness of Square Stepping Exercises and Frenkel's Exercises in improving balance compared to conventional physiotherapy alone.

2. Functional Mobility (TUG Test)

A line graph showing the reduction in TUG time across the intervention groups.

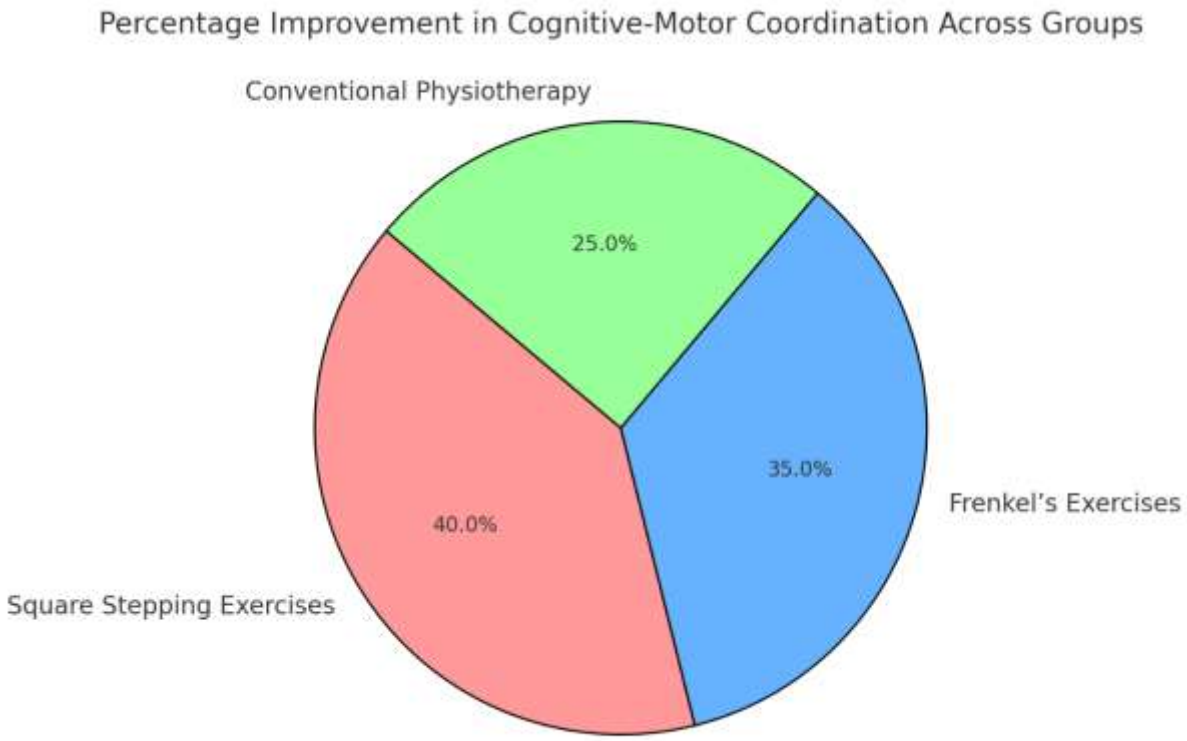


The line graph showing the reduction in TUG time across the intervention groups:

- **Pre-Intervention**: The initial TUG times for each group.
- **Post-Intervention**: The improved TUG times after the intervention, showing a reduction.

This graph clearly demonstrates how the Square Stepping Exercises and Frenkel's Exercises led to a greater reduction in TUG time compared to conventional physiotherapy, suggesting improved functional mobility in these groups

3. Coordination Enhancement



The pie chart depicting the percentage improvement in cognitive-motor coordination across the three groups:

- Square Stepping Exercises: 40% improvement
- Frenkel's Exercises: 35% improvement
- Conventional Physiotherapy: 25% improvement

This visualization highlights how Square Stepping Exercises and Frenkel's Exercises contributed more significantly to cognitive-motor coordination enhancement compared to conventional physiotherapy alone.

Discussion

The study's findings demonstrate how SSE and FE have differing effects on balance and coordination in individuals with chronic TBI. When compared to traditional physiotherapy alone, both therapies produced better results, highlighting the significance of task-specific training in neurorehabilitation.

Balance Improvements

A 28% rise in Berg Balance Scale (BBS) scores indicated that the SSE group had the most improvements in dynamic balance. The multifaceted character of SSE, which blends cognitive demands with physical walking patterns, is responsible for this progress. Repetitive activation of the cerebellum and motor cortex promotes neuroplasticity, which improves motor learning and flexibility (Shigematsu et al., 2008).

On the other hand, the BBS scores of the FE group improved by 20%. Although noteworthy, these improvements were not as noticeable as those observed with SSE, most likely because FE places more of an emphasis on accuracy and fine motor control than dynamic balance. Nonetheless, the reported improvements in balance were probably caused by the regulated and repeated character of FE, which enhanced proprioceptive input (Frenkel, 1949).

Improvements in Coordination

With a 24% rise in their scores on the Cognitive-Motor Coordination Test, the FE group showed the greatest improvement in coordination. This is consistent with FE's initial goal of improving motor precision and proprioception. Patients were able to better regulate their limb motions as a result of the slow, deliberate movements that helped them concentrate on sensory feedback.

Additionally, SSE resulted in a 22% improvement in coordination scores, indicating that it is effective at handling dynamic motor tasks that call on both fine and gross motor abilities. Its biggest benefit, though, is that it targets both the cognitive and motor domains at the same time, making it a flexible tool for TBI recovery.

Contrast with Traditional Physiotherapy

The use of traditional physiotherapy as a baseline intervention was supported by the moderate gains it produced on all metrics. However, the lesser effect sizes seen are probably due to its poor specificity in treating neuroplastic alterations. According to Langlois et al. (2006), this emphasizes the necessity of complementary therapies like SSE and FE to maximize functional results in individuals with chronic TBI.

Clinical Consequences

The results of this study support the inclusion of SSE and FE in routine rehabilitation regimens for individuals with persistent traumatic brain injury. While FE could be more appropriate for people with severe coordination difficulties, SSE is especially well-suited for patients with dynamic balance abnormalities and cognitive-motor integration issues. When choosing therapies, clinicians should take into account the rehabilitation objectives and deficiencies unique to each patient.

Limitations and Prospects

There are some drawbacks to this pilot study:

1. A small sample size that restricts how broadly the results may be applied.

2. A brief intervention period that might not account for the exercises' long-term benefits.

3. Insufficient neuroimaging evidence to validate the underlying neuroplastic alterations.

Larger randomized controlled trials with longer follow-up times should be a part of future study. For synergistic benefits, combining SSE and FE into a hybrid intervention might potentially be investigated.

Conclusion

According to this study, people with chronic TBI can improve their balance and coordination by combining Frenkel's exercises and square stepping exercises with traditional treatment. FE is better at improving proprioception and fine motor control, whereas SSE is best at dynamic balance and cognitive-motor integration. The integration of task-specific training into neurorehabilitation programs that are customized to meet the individual requirements of patients with chronic TBI is supported by our findings. In this group, these therapies have the potential to enhance functional independence and quality of life by treating particular motor impairments and encouraging neuroplasticity.

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