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## Otago exercises on fall prevention in stroke patient: A case study

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### Abstract

A stroke happens when blood flow to the brain stops suddenly, causing brain damage. Balance and gait impairments are commonly complained of by post-stroke patients. This study investigates the effectiveness of Otago exercises in reducing fall risk in stroke survivors. A 60-year-old male patient presented to the outpatient department (OPD) with difficulty in standing with eyes closed and narrow base of support, tandem stance with eyes open and closed, single leg stance, and walking on heels and toes. The patient underwent four weeks of rehabilitation, attending 50-minute physiotherapy sessions for five days per week. The Tinetti POMA scale score increased by 7 points and the dynamic gait index by 5 points post-intervention. After the intervention, the patient could stand with eyes closed and a narrow base of support, stand on one foot, and walk on toes, and heels. This study concludes that Otago exercises can be beneficial for stroke patients in reducing fall risk and improving balance and gait.

**Keywords:** Fall prevention, Otago exercises, stroke, weakness

### Introduction

Cerebrovascular accident (CVA), commonly known as stroke, results from a sudden blood flow disruption in the brain and can lead to disruption of brain function, which causes symptoms like weakness or speech difficulties that persist for more than a day and may even be fatal <sup>[1]</sup>. Stroke is ranked as the third leading cause of death. Annually, an estimated 80.1 million people around the world are affected by stroke, with 6.2 million tragically losing their lives. Stroke is a major cause of death and disability, mostly affecting adults, and is a notable global health concern <sup>[2]</sup>. A concerning increase in stroke frequency has been noticed in low- and middle-income countries. This surge is linked with various potentially modifiable risk factors, such as environmental, metabolic, occupational, physiological, and behavioral factors <sup>[3]</sup>. Stroke survivors are notably more vulnerable to falls than the general aging population, with a fall frequency rate between 36% and 73% in the first 6 months following discharge. This risk rate remains high, disturbingly affecting 40% to 58% of individuals even a year post-stroke. Falls are considered a major complication post-stroke, undoubtedly leading to a further decline in mobility and daily activities <sup>[4]</sup>.

Furthermore, a strong reliance on assistance with activities of daily living (ADLs) is seen in high-risk fall patients. In addition, quality of life (QoL) is strongly linked to fall risk and overall balance <sup>[2]</sup>. Exercise training is a major cornerstone of stroke rehabilitation which helps patients regain lost function post-stroke <sup>[5]</sup>. Exercise programs that aim to improve muscle strength and balance can reduce falls <sup>[6]</sup>. The fall prevention program is followed by the Otago Exercise Program (OEP), which focuses on three key components: muscle strengthening, balance training, and walking. The OEP commences with exercises targeting head, neck, back, trunk, and ankle movements. These are followed by muscle-strengthening exercises for the knee flexors, extensors, hip abductors, ankle plantar, and dorsiflexors. Balance training includes knee bends, backward walking, walking with turns, sideward walking, heel-toe standing and walking, single-leg standing, heel walking, toe walking, backward heel-toe walking, sit-to-stand transitions, and stair walking. The program involves 50-minute sessions, five times a week for four weeks <sup>[1]</sup>.

Otago exercises improve ankle and hip strategies, allowing the body to move as a unit with activated foot muscles for better ground contact. As speed increases, the body naturally adopts

a hip-dominant strategy. Overall, otago exercises benefit walking, posture control with improved movement patterns and muscle activation, and balance with better control of your center of gravity [1]. Due to the risk of falls in stroke patients, this study aims to evaluate whether Otago exercises can be a solution for fall prevention.

## 2. Case Report

A 60-year-old male patient presented to the OPD with a history of sudden-onset right-sided weakness that occurred in February 2023. Despite experiencing these symptoms in the evening, he did not seek immediate medical attention. The weakness worsened the next day, prompting him to visit a tertiary hospital in Mangalore. An MRI scan revealed a left lacunar infarct in the left basal ganglia and chronic ischemic changes in the bilateral centrum ovale and corona radiata. He received inpatient care for one week at the hospital, including a brief course of physiotherapy, before discontinuing treatment. Two months later, he underwent Ayurvedic treatment in Mangalore. In December 2023, he returned to the OPD complaining of weakness on the right side of his body and balance loss during daily activities. Examination revealed involvement of the vestibular portion of the vestibulocochlear nerve. Balance testing, including standing with eyes closed and a narrow base of support, tandem stance with eyes open and closed, and single leg stance support showed abnormalities. Further evaluation confirmed impaired equilibrium, evident in difficulties standing on one foot, walking on heels, and walking on toes. According to the Tinetti POMA scale, the patient has a high fall risk (16/28), and the Dynamic Gait Index also indicates a predictive fall risk (14/24).

### 2.1 Physiotherapy Management

The patient was scheduled for physiotherapy for 50-minute sessions on weekdays during his rehabilitation. The patient attended the session on weekdays for 4 weeks. The short-term goals were to increase strength and improve balance and gait. The long-term goals of the intervention were to reduce the risk of falls and improve quality of life. The intervention plan and care focused primarily on reducing fall risk and improving ADL. The OEP begins with warm-up exercises such as head movements, neck movements, trunk rotations, back extensions, and ankle and toe movements. These progress to muscle-strengthening exercises using weight cuffs for knee flexors and extensors, hip abductors, ankle plantar flexors, and dorsiflexors. Balance training incorporates activities like knee bends, walking variations (backward, turns, sideways), heel-toe exercises (standing and walking), single-leg standing, and transitions like sit-to-stand and stair walking.

### 2.2 Outcome Measures

The Tinetti Performance-Oriented Mobility Assessment (POMA) is a valuable tool for assessing balance and gait impairments in stroke patients, thereby helping to determine their fall risk. The Tinetti POMA consists of two parts: a gait score (maximum 12 points) and a balance score (maximum 16 points). The Tinetti POMA uses a 3-point scoring system (0: unable to perform, 1: needs help, 2: performs fully) to evaluate each item. The total possible score is 28, with higher scores indicating better balance and gait function, and a lower risk of falls. A study by Jennifer Canbek *et al.* (2013) demonstrated good test-retest reliability (ICC = 0.84) of the Tinetti POMA scale in stroke patients undergoing rehabilitation [7]. So, the Tinetti POMA is considered as a

reliable and valid tool for assessing balance and gait in post-stroke patients.

The Dynamic Gait Index (DGI) is a clinical tool used to assess gait, balance, and fall risk. It evaluates an individual's ability to maintain walking balance under various challenging conditions. The DGI involves observing a person performing eight tasks and assigning scores based on their performance.

A 4-point ordinal scale is used

3 - No gait dysfunction

2 - Minimal impairment

1 - Moderate impairment

0 - Severe impairment

The maximum possible score is 24 points. Ahmad H Alghadir *et al.* (2018) on his study showed good test-retest reliability (ICC = 0.98) of the Dynamic Gait Index in post-stroke patients. [8] Therefore, the Dynamic Gait Index is a reliable and valid tool for assessing gait in stroke patients.



Fig 1: Patient is moving head to right and left



Fig 2: Patient is extending back



Fig 3: Patient is walking sideways



**Fig 4:** Patient is standing on one foot

### 3. Result and Discussion

**Table 1:** Pre and post scales

Scale	Pre-data	Post-data
Tinetti Poma Scale	16/28	23/28
Dynamic Gait Index	14/24	19/24

**Table 2:** Pre and Post-Equilibrium test

Equilibrium Test	Pre Assessment Grade	Post Assessment Grade
Standing with eyes closed	2	3
Standing with a narrow base	3	4
Standing on one foot	0	2
Walk on heels	0	2
Walk on toes	0	3

The current study was done to determine the effectiveness of Otago exercise on fall prevention in stroke patients. The Otago exercises are found to be beneficial in stroke patients with fall risk.

Four weeks of Otago exercises led to marked improvements in balance and gait. Since strong muscles are crucial for walking, the program included strengthening exercises for knee flexors, extensors, hip abductors, ankle plantar flexors, and dorsiflexors. Weight cuffs added resistance to these exercises. Balance retraining exercises, which help stroke patients regain control of their body position and movements, reducing the risk of falls, included knee bends, backward walking, walking with turns, sideways walking, tandem standing and walking, single-leg stand, heel walking, and toe walking, sit-to-stand, and stair walking.

In this study patient showed a noticeable difference in balance and gait after applying Otago exercises such as strengthening and balance retraining exercises. However, there is no remarkable improvement in activities of daily living and quality of life. Similar to the findings in this study, Park *et al.* (2016) also demonstrated the effectiveness of the Otago exercise program for elderly stroke patients. Their study concluded that the Otago program significantly improved fall efficacy, but the improvements in activities of daily living and quality of life were not statistically significant [2].

The Tinetti Performance-Oriented Mobility Assessment (POMA) scale was used to assess balance and gait in this study. The use of the Tinetti POMA scale is supported by a

study conducted by Jennifer Canbek *et al.* (2013).

This study evaluated the reliability and validity of the Tinetti POMA for stroke patients. This study showed that the Tinetti scale's (POMA) reliability and ability to assess balance in stroke patients is good [7]. In this study, the patient's Tinetti Poma Scale score increased from 16/28 to 23/28 after the exercise.

Gait assessment of the patient in this study was assessed using a Dynamic Gait Index scale (DGI). The Dynamic Gait Index (DGI) is a reliable and responsive tool for measuring balance, as supported by a study by Ahmad H Alghadir *et al.* (2018). Their study compared the reliability, validity, and responsiveness of three balance scales (TUG, BBS, and DGI) and found that DGI is slightly better at detecting changes over time [8]. In this study, the patient's DGI score increased from 14/24 before the exercise program to 19/24 afterward.

People with stroke who exercise regularly experience improvements in their overall balance and mobility. Analysis of the current results suggests that Otago exercises effectively reduce fall risk in stroke patients. However, further research is needed to determine whether they are definitively better than other options

#### Limitations of the study

- The study duration was limited to four weeks.
- The study cannot determine whether the effects of balance and gait training were short-term or long-term.
- Balance and gait assessment can vary according to the outcome measures even though the objective remains the same.

#### Scope of study

- Further research can be conducted in a larger population with longer duration, with different outcome measures, and with different exercise therapy interventions for individuals with fall risks after stroke.
- A comparative study can also be done comparing this intervention with other treatment options to find out which treatment protocol provides better results in the cases of fall risk after stroke in future studies study was conducted over a short period of four weeks.

#### 4. Conclusion

This study concluded that Otago exercises can be beneficial for stroke patients in reducing fall risk and improving balance and gait.

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