

Original Article

Immediate Effects of Toe Spreader on Balance in Subacute and Chronic Stroke Patients

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ABSTRACT **Background:** Stroke is one of the commonest neurological disorders causing functional disability. Toe spreader is proven to improve gait in these patients but a study of its effect on balance was yet to be performed. **Objective:** The purpose of the study was to find out effect of toe spreader on functional and dynamic balance in subacute and chronic stroke patients. **Materials and Methods:** Thirty subjects were recruited in the study. Balance assessment was performed using Berg Balance Scale for functional and timed up and go test for dynamic balance. Both being tested first without the toe spreader and then immediately after toe spreader application and documented, respectively. **Results:** This study found out that around 87% of the subjects showed a reduction in time in the timed up and go test scores post-usage of toe spreader, whereas all subjects showed an enhancement in the total berg balance scale score. Paired *t* test was used for parametric data analysis whereas Wilcoxon signed rank test was used for non-parametric data analysis (level of significance being $*P \leq 0.05$). The obtained $*P$ value for Berg Balance Scale was 0.000 and timed up and go test was 0.001. **Conclusion:** The conclusion drawn from the results of this study is that toe spreader has a significant effect on improving the balance in subacute and chronic stroke patients.

KEYWORDS: Balance, chronic, stroke, subacute, toe spreader

INTRODUCTION

Stroke is said to be one of the major causes of various disabilities and finally death in various parts of the world. It is increasing due to lack of awareness and ignorance of the possible risk factors and thereby poses a worldwide health threat.^[1] Stroke is a condition showing the rapid development of clinical signs of focal (or global) cerebral function disturbance, along with symptoms that last up to 24h or longer. It may eventually lead to death, with no apparent cause other than a vascular origin. There are various types of stroke, the major two being, ischemic stroke, which is due to the occlusion of blood vessels, which in turn reduce the blood flow to the brain, and hemorrhagic stroke that occurs when the blood vessels rupture leading to an intracerebral bleed.^[2] Risk factors causing stroke can be modifiable namely diabetes, hypertension,

smoking, etc., or nonmodifiable such as age, gender, genetic, and race.^[3]

There are three main phases to be considered, which are the acute phase, subacute phase, and chronic phase. The acute phase starts from the day of occurrence (day 0) till the seventh day. The subacute phase lasts for about 6 months starting from the eighth day, whereas anything lasting from 6 months and later is considered as the chronic phase.^[4]

The incidence of stroke is much more in men as compared to women and the age groups that suffer from stroke are generally above 50 years.^[5] Stroke can also be

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categorized depending on the vascular region involved that is middle cerebral artery (MCA), anterior cerebral artery, posterior cerebral artery, lacunar stroke, etc.; MCA being the most commonly affected generally.^[6]

Sudden warning signs that help us detect stroke at an early stage are weakness in one side of the face, arm, or leg, blurred vision, slurry speech, dizziness, balance as well as coordination issues. Of all these, one of the most disabling symptoms is the loss of balance that is observed in patients which in turn leads to affection in daily activities and increased chances of falls.^[7] The main reasons for impaired balance in these patients are the loss of proprioception and loss of limb control. Also, the muscle imbalances with lower limb muscle weakness, and further lead to ambulation difficulties.^[8] Other problems such as reduced ankle proprioception, alterations in plantar sensory inputs, and motor control affection add up to the problems in the balance of stroke patients.^[9]

The balance in these patients is usually checked by two components: functional and dynamic. In this study, the functional balance was checked using Berg Balance Scale. This is a 14-component scale with the lowest score possible being 0 and the highest being 56.^[10] As for dynamic balance, the Timed Up and Go test (TUG) is usually used which involves the time taken to cover a total of 6 m via independent ambulation.^[11]

To overcome these problems, there is a combination of rehabilitation techniques that need to be inculcated that include lower limb strengthening, balance training exercises, and motor relearning programs.^[12] In addition to this, usage of orthotic devices provides extra support to improve the overall balance in stroke patients, one of them being toe spreader. It helps in reducing foot impairments that result in balance problems as well as improves the overall ambulatory status of the patient.^[13]

This study explored any immediate effect of toe spreader on balance in subacute and chronic stroke patients.

MATERIALS AND METHODS

A quasi-experimental study design using purposive sampling was conducted in the state of Maharashtra. The duration of the study was 6 months. A total of 30 individuals were included in the study and, respectively, assessed. Patients were recruited from not only private and government-aided hospitals, but also from private well-established neuro-physiotherapy clinics and community-based patients as well [Table 1]. In total, 21 men and 9 women aged 20–70 years^[5] were recruited. The inclusion criteria of the study included

individuals with MCA infarct,^[14] individuals with subacute-to-chronic stroke,^[4] and individuals who were able to independently ambulate for at least 6m (to fulfil the TUG test).^[11]

Individuals with vestibular disorders,^[15] cognitive impairments,^[16] lower limbs soft tissue or bony injuries^[17] have been excluded from the study. Assessment tools in the local language were provided to subjects who could not understand English.

Procedure

After seeking permission from the Institutional Research Committee and following the CONSORT guidelines, subjects who met the inclusion criteria and willingly agreed to participate in the study were included. Detailed information regarding the procedure and its effects were explained to them and a consent form was filled by all the participating subjects. First, the balance was assessed in the subjects without the application of the toe spreader and then the entire procedure was again repeated but after application of the toe spreader. For calculation of functional, Berg Balance Scale was used, whereas the TUG was used to calculate the dynamic balance. The test–retest reliability of the measuring methods was high, ICC 0.98 and ICC 0.80, respectively.

The materials used were a toe-spreader, stool or a chair, cones, small stepper, long ruler, markers, timer, measuring tape, some object (to perform picking an object from the ground), and a copy of Berg Balance Scale.

For the testing procedure, the subjects were asked to wear comfortable clothing and to perform all the tests without footwear. Timed Up and Go required marking of a 3 m path in a long corridor with the help of markers with a cone on one end and a chair on the other. With the use of a timer, the time needed to get up, complete an

Table 1: Demographic data of subjects showing the variance in age and gender

Total number of subjects (N)	30
Gender	
Males	21
Females	9
Age groups	
20–30	5
31–40	9
41–50	4
51–60	4
61–70	8
Mean ± std. dev. of age	46.93 ± 15.44

entire to and fro round of the 3 m pathway, and then sit back on the chair was calculated, first without the use of a toe spreader and then with applying the toe spreader between the great toe and the second toe [Figure 1]. The respective scores were documented and the difference was noted down.^[11]

The Berg Balance Scale has 14 components that have to be performed, sit to stand, stand to sit, sitting unsupported, pivot turning, standing unsupported with eyes open and eyes closed, reaching forward, looking over the shoulder from both sides, 360° turn, step up and down on a stool, tandem standing, one leg stance; starting with no toe spreader and then after immediate application of the toe spreader. For the scoring purpose, it consists of a 5-pointer scale ranging from 0 to 4: 0 being the lowest, whereas 4 being the highest score possible. Depending on the Berg Balance Scale and TUG, the respective pre and post-application of toe spreader scores were documented along with other relevant demographic data

of the patient. The completion of the entire procedure took about 35 min per patient.

Statistical analysis was done using IBM Statistical Package for the Social Sciences (SPSS) software program, version 26.0. Paired *t* test was used for the parametric data, whereas Wilcoxon signed-rank test was used for the nonparametric data, with the value of the level of significance (LOS) set at $P \leq 0.05$.

RESULTS

Thirty stroke patients participated in this study; of these, 21 were men and 9 were women. Among these, 15 were patients with subacute stroke, whereas the rest 15 were patients with chronic stroke.

DISCUSSION

After interpreting the assessed data, of total 30 subjects [Figure 2] approximately 87% of subjects showed a reduction in time taken to complete the TUG post usage of toe spreader, indicating an improvement in dynamic

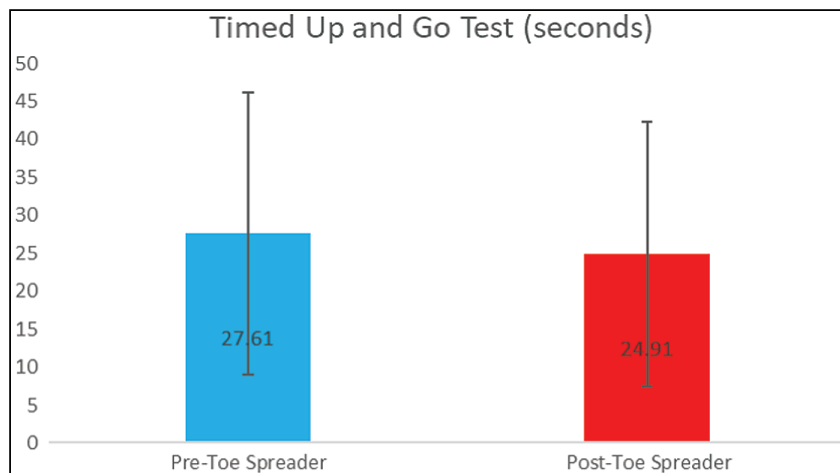


Figure 1: Timed up and go test

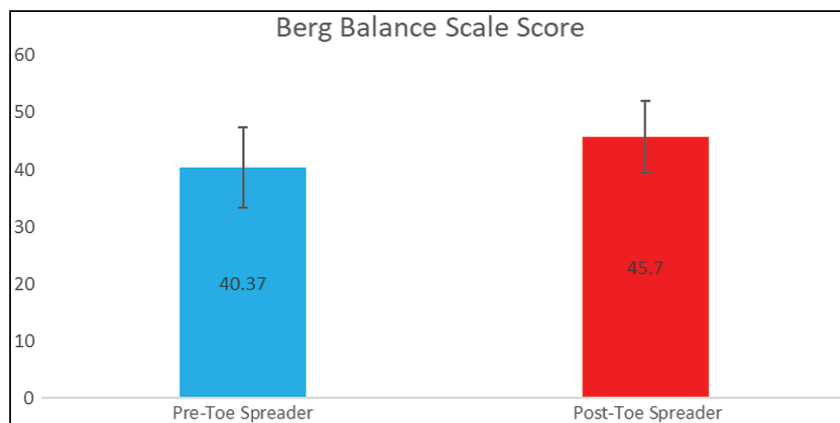


Figure 2: Berg Balance Scale



Figure 3: Toe spreader application

balance [Figure 3], whereas all subjects showed an enhancement in the functional balance via the increase in the total Berg Balance Scale score.

The reason for these results could be either of the two mechanisms or both the mechanisms that are correction of claw toe deformity and inhibition of tonic toe flexion reflex by the toe spreader. In claw toe deformity, there is hyperextension at the metatarsophalangeal joint with flexion at the proximal interphalangeal and distal interphalangeal joints that are caused due to many factors such as overactive toe flexors without any compensation by the toe extensors. It is one of the most common deformities that are seen in stroke patients.^[18] In most cases, if not treated on time, this claw toe leads to reduced gripping ability in the foot and thereby exposing the stroke patients to a greater risk of falls. A study by Lee *et al.*^[13] studied the effects of toe spreader on plantar pressure and gait in chronic stroke patients, and found significant improvement in overall spatiotemporal parameters of gait. The role of the toe spreader in rectifying this deformity was not only to push the Metatarsophalangeal joint in a neutral position and support the interphalangeal joints in a

slight extension to avoid excessive flexion but also to assist the weak toe extensors to equalize the force of the toe flexors. Along with this, it also provided additional mechanical support and stability to the foot during the stance phase of the gait cycle and thus improved the overall gait and balance. Along with the above effects, the toe spreader also helps to reduce the pressure on the great toe and distribute the force over the other areas of the foot equally especially the outer foot border, thereby improving the push-off phase of the gait cycle and improving the overall gait of the patient. Another study by Lee *et al.*^[13] showed the effects of toe spreader on the activities of Tibialis Anterior and Peroneus Longus muscles and found that there were alterations in their activities seen post usage of the toe spreader, thus providing mediolateral foot stability during ambulation. Taking a look at another major disability being the tonic toe flexion reflex. A previous study^[18] showed the successful toe flexion reflex inhibition by the toe spreader and thereby altering and improving the gait parameters as well, which is improving the gait velocity and cadence. Tonic toe flexion reflex is the prolonged involuntary plantarflexion or curling of toes that is seen after withdrawal from an evoking stimulus. The nature of the stimuli can be as small as light pressure on the plantar surface of the foot (usually distally) or else as high as painful and intense stimuli over the foot that can lead to flexor synergy of the toes. This further interrupts the overall gait cycle in patients and impairs the balance as well.

In such cases, the toe spreader plays a role in inhibiting this exaggerated reflex. The structure of the toe spreader was such that it prevented the flexion of toes at the MTP as well as the IP joints after exposure to any kind of stimuli, thereby maintaining the base of support of the patient and thus in turn improving the overall balance as well.

Materials of these toe spreaders also play an important role in these patients as there are high chances of impaired sensations that could be present. Thus, the material used in our study was the microcellular rubber as it has several advantages such as it provides proper cushioning to the toes and plantar aspect of the foot that helps in reduction of pain and improvement of gait; it also prevents ulcer formation and protects the part of the foot that may have altered sensations.^[18,19]

Thus, the toe spreader proves to be an effective rehabilitation tool for enhancing stability and treating balance-related problems in subacute and chronic patients.

Conclusion

This study indicates that the usage of a toe spreader might help improve overall balance in subacute and chronic stroke patients.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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