Effects of elastic band orthosis (aider) on balance and gait in chronic stroke patients

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Objective: The objective of this study was to investigate the feasibility and effects of balance training using a newly developed elastic band orthosis (aider) for improvement of mobility and balance in chronic stroke patients.

Design: Cross-sectional study.

Methods: Ten patients with chronic hemiplegia participated in this study. There were six males and four females; two patients had right hemiplegia and eight had left hemiplegia. This study investigated the effect of the elastic band orthosis on balance and gait ability compared with bare foot condition. Gait parameters were measured using the opto-gait system for analysis of the spatial and temporal parameters of walking in stroke patients. In addition, balance ability in stroke patients was evaluated using the Timed Up and Go (TUG) and Berg Balance Scale (BBS).

Results: This study investigated the effect of the elastic band orthosis on balance compared with bare foot condition. The TUG and BBS showed significant improvement with use of the elastic band orthosis \( (p<0.05) \). Use of the Elastic band orthosis resulted in significantly improved velocity, cadence, less-affected step length, less-affected stride length, and less-affected single limb support in stroke patients \( (p<0.05) \).

Conclusions: We demonstrated a significant improvement in dynamic balance and gait ability in chronic stroke patients using the elastic band orthosis. This orthosis may aid in prevention of spastic foot drop, leading to improvement of walking ability.

Key Words: Ankle-foot orthosis, Balance, Gait, Stroke

Introduction

The ability to walk independently is a life enriching activity and the most efficient way of getting from one place to another in the course of our daily lives [1]. Stroke often results in dysfunction of one side of the body termed hemiplegia [2]. Compared with able bodied persons, the gait of persons with hemiplegia is less metabolically efficient and leads to increased falls [3,4]. Limitation of the ability to walk is one reason for restricted mobility locomotor disability after stroke [5].

Problems with poor balance, instability in stance, hyper-tonicity, inappropriate and involuntary posturing of the foot and ankle, and recurvatum and instability at the knee have led to the recommendation that orthoses be incorporated in the lower limb management of patients after stroke [6]. For example, approximately 20% of stroke patients suffer from spastic foot-drop, which is an inability to dorsiflex the foot and can cause deficiencies in toe clearance during gait [7,8]. Ankle-foot orthosis (AFO) is currently the most widely used orthoses in the United States, accounting for 26% of clinical practice by certified orthotists [9]. AFOs are generally used to assist hemiplegic patients in regaining walking ability [10], preventing foot-drop and the occurrence of toe clearance problems, promoting mediolateral ankle stability during standing, and promoting heel strike [11].
Several researchers, however, insist that there are some problems with AFOs, such as disuse of the ankle dorsiflexor when patients undergo gait training with AFOs for a long period of time, as well as a lack of evidence for increased muscle activation [12]. Thus, it remains uncertain whether AFOs should be considered for improvement of functional recovery in stroke patients as they may replace muscle activity according to the degree of assistance. In addition, some researchers have indicated that immobilization of the ankle with AFOs would induce muscle disuse [13]. Articulated AFOs with plantar flexion stops are frequently provided for patients with hemiplegia [12].

Therefore, development of a new assistive device for stroke patients that is lighter, portable, and better customized, with a low cost is needed.

In this study, we compared the effect of elastic band orthosis and bare foot condition on balance and gait patterns in stroke patients.

Methods

Subjects

Ten participants diagnosed with hemiplegia were recruited from W Medical Center in Wonju, Korea. There were six males and four females; two patients had right hemiplegia and eight had left hemiplegia (Table 1).

Inclusion criteria were (a) a diagnosis of hemiplegia due to hemorrhagic or ischemic stroke, (b) more than six months post-stroke, (c) the ability to follow simple instructions, (d) the ability to walk independently or with an assistive device, and (e) no orthopedic problems involving the lower extremities that would affect gait.

Exclusion criteria were (a) a stroke involving more than one hemisphere, (b) more than two strokes, and (c) pre-morbid or other orthopedic problems that would impede gait patterns. Informed consent was provided by the subjects prior to the start of the study. The study was approved by the Sahmyook University Ethics Committee.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean (SD)</th>
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<tbody>
<tr>
<td>Age (yr)</td>
<td>56.8 (13.51)</td>
</tr>
<tr>
<td>Gender* (male:female)</td>
<td>6:4</td>
</tr>
<tr>
<td>Affected side of stroke* (right:left)</td>
<td>7:3</td>
</tr>
<tr>
<td>Stroke onset (mo)</td>
<td>42.30 (17.11)</td>
</tr>
</tbody>
</table>

*Frequency.

Procedures

Before conduct of the tests, the investigators demonstrated walking on the Optogait system. The participants were asked to walk at a comfortable speed. Assistance was provided if the subjects required it for safety. Each test was performed over the course of five trials by each participants and a 2-min rest period was provided between tests. Participants performed the test initially with bare feet for 1-2 m to allow them to adapt to walking on it before they used the elastic band orthosis.

Outcome measures

Timed Up and Go test

The Timed Up and Go (TUG) is a time measured test that requires standing up, walking straight for 3 m, turning, walking back to the chair, and sitting down. In this study, participants sat comfortably on a chair and did not use back support. They were timed for the TUG as soon as their buttocks lifted from the chair and as soon as their buttocks touched the seat. For turning, they moved toward the unaffected side. A time less than 10 seconds indicated functional independence, and a time more than 30 seconds indicated functional dependence. The time was recorded using a stopwatch. The intrarater reliability of the TUG was high in individuals with chronic stroke. One study reported an ICC of 0.95 (95% confidence interval [CI], 0.84-0.99), and another study reported an ICC of 0.96 (95% CI, 0.93-0.98) [14,15].

Berg Balance Scale

The Berg Balance Scale (BBS) is a functional balance measurement consisting of 14 items. Each item is a 5-point ordinal scale ranging from 0 to 4, with 0 indicating an inability to complete the task entirely and 4 indicating an ability to complete the task criterion. Scores can range from 0 to 56. The higher the score, the better the postural control for individuals with stroke. Cronbach’s $\alpha$ of the BBS ranged from 0.92 to 0.98 showing high internal consistency [16]. The inter-rater reliability had an ICC of 0.95 (95% CI, 0.93-0.97), the intra-rater reliability was high (ICC=0.97), and the test-retest reliability had an ICC of 0.98. [17,18].

Optogait system

The Optogait system used in this study consisted of five transmitting and five receiving bars, which were placed parallel to each other (3×0.5 m) for collection of gait