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Original Article

Improve elderly people's sit-to-stand ability by using new designed additional armrests attaching on the standard walker

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Abstract

Background: More and more elderly problems come to our life and the elderly health care become more important. Elderly people with lower extremities weakness usually use walkers to assist in walking. Although the commercial standard walkers (N-type) can improve elderly people's walking ability, users sometimes take risk of falling when using the standard walkers to perform sit-to-stand (STS). The purpose of this study is to design an additional armrest which can be attached to a standard walker for users performing STS more easily and evaluate it with clinical assessments and a body worn sensor.
Methods: The combination of the walker and the new armrest design are referred to as a better type (B-type). Clinical assessments and a motion analysis were performed on 34 elderly people (age, 83 ± 6 y/o) with a Five Times Sit-to-Stand Test (FTSST), a satisfaction survey and an inertial measurement unit (IMU) attached to the trunk to measure the acceleration data when using B-type and N-type during STS.
Results: The FTSST result shows that the B-type can reduce about 5 s spending time of elderly people during STS and 63.7% of subjects were more satisfied on the B-type than the N-type. According to the IMU, the result reveals that the B-type can provide subjects higher peak−peak anterio-posterior acceleration, peak flexion acceleration and peak extension acceleration during STS.
Conclusion: There is a better assistance during STS when using our new armrests design combined with the commercial product which could provide larger acceleration to perform sit-to-stand.

Keywords: Acceleration; Elderly; Five times sit-to-stand test; Inertial measurement unit; Sit-to-Stand; Walker

1. Introduction

Many developed countries are on course to go from being an aging society to an aged society. Falls are one of the common and serious problems among elderly people. Most of these falls are associated with weaker balance controls, and these conditions may also have identified as some risk factors.

Factors affecting the balance conditions of elderly people include visual system, vestibular system, somatosensory system, muscle strength and reaction time.[1,2] As lower extremities weakness is one of the common problems that causes imbalance in elderly adults,[3] walkers are usually use to assist in walking. There are two functions that a walker must require: (1) Weight-bear and keep balance when walking, (2) Sit-to-

Conflicts of interest: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

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stand assistance.[4] Standard walker (called N-type in this article) and UpRise Onyx Folding Walker (called R-type) which is a combination of folding walker and rising aid are the commercial products showed in Fig. 1. The height of armrest of N-types walker was designed for users to walk, but not easily used in performing sit-to-stand. The reason is that the armrests are too high to apply downward force by hand for sit-to-stand assistance if the user has lower extremities weakness. In another commercial product, R-type walker is designed in armrests with two levels. The high level is as high as N-type walker for users well used in walking and the low level is 10 cm lower than N-type walker armrests to assist users in performing sit-to-stand. However, the low level armrests are designed in the backend of the walker. In clinical phenomenon, users' COM will be backward in the base of support and cause the user have higher fall risk when holding low-level armrests when using R-type to perform sit-to-stand. As a result, the R-type walker is still considered not a well design for users.[5]

Many researchers have conducted some experiments on the stability of sit-to-stand.[6] One of the well-used methods is the Sit-to-stand test. The Sit-to-Stand Test has been used to identify some clinical assessment, including postural control, fall risk, lower-extremity strength, proprioception and as a measure of disability. The Five Times Sit-to-Stand Test (FTSST) has been related to standing and postural control and to falls in older adults.[7] Furthermore, the FTSST is suitable for subjects with disability according to the advantage of in expensive equipment and without space constraints. Many researches have investigated the validation of FTSST data with other clinical tests and suggested that the FTSST is a valid measure of dynamic balance and functional mobility in older adults.[7−11]

In addition to clinical assessment, some electrical devices were used to identify the clinical assessment recently. The force plate and motion capture system are the most common used devices to evaluate the fall conditions of elders.[12] In these years, the inertial measurement unit (IMU) is one of the options in motion analysis. An IMU sensor could provide precise measurement. It has replaced the force platform as a clinical assessment device because the properties of an IMU including portable and inexpensive.[13] The portable trait make IMU sensors have well useful in experiment out lab door and the small volume make the IMU well attached to a subject's chest or pelvis.[14−16] The IMU will not cause uncomfortable to the subject. Using the three-dimensional acceleration and velocity measuring ability of IMU, the subject can be measured anterio-posterior (AP), medial-lateral moving (ML), and superio-inferior data (SI) base on the defined axes.[14,16] Among the sit-to-stand, the AP and SI data can reflect the subject's stability more directly.[17] Some researchers also use IMU to study motion properties in daily activities such as walking, running, standing, sitting and brushing teeth.[17,18] Moreover, the IMU can determine the difference of balance performance in different groups of people such as evaluation the difference of sit-to-stand in elders and youngsters.[19]

The purpose of this study is to design an additional armrest on the standard walker in order to assistant on performing sit-to-stand with the elderly, and to evaluate the consequence by using clinical assessment and a body worn sensor.

2. Methods

A new design of components for walker were successfully modified the N-type walker. The new design was assumed as a better type and referred as B-type in this article. For B-type, two armrests which were 10 cm lower than N-type were attached to both sides of middle bars on N-type to provide two better force exertion places in performing sit-to-stand (Fig. 2).

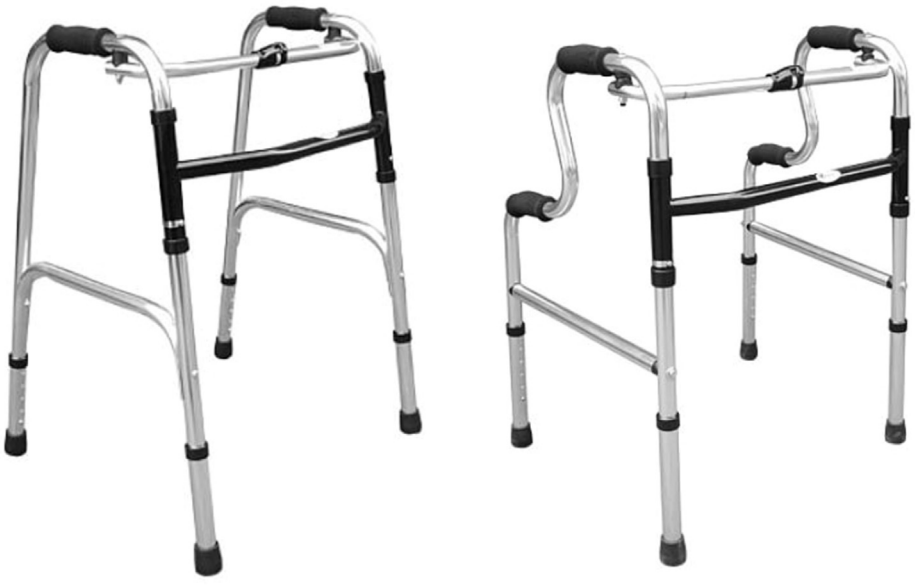

Fig. 1. Different type of commercial walker: (a) N-type, (B) R-type.

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