ISSN 2733-6441 / eISSN 2733-645X http://dx.doi.org/10.26862/jkpts.2022.03.29.1.41

대한물리치료과학회지
Journal of Korean Physical Therapy Science
2022. 03. Vol. 29, No.1, pp. 41-46

Development and feasibility test of sit-to-stand transfer assistive device

SinHo Ha[1], Ph.D., candidate, P.T. · SeYeon Jeong[1] · SoungKyun Hong[2] · Wonjae Choi[3] · Kwangkook Lee[4] · Donghwan Park[6] · SangJun Son[1] · HyeonHui Shin[5] · GyuChang Lee[6], Ph.D., P.T.

[1]Department of Physical Therapy, Graduate School of Kyungnam University, Changwon, Republic of Korea
[2]Department of Physical Therapy, Woosuk University, Wanju, Republic of Korea
[3]Department of Physical Therapy, Joongbu University, Geumsan, Republic of Korea
[4]Department of Naval Architecture and Ocean System Engineering, Kyungnam University, Changwon, Republic of Korea
[5]Department of Occupational Therapy, Dongseo University, Busan, Republic of Korea
[6]Department of Physical Therapy, Kyungnam University, Changwon, Republic of Korea

Abstract

Background: The purpose of this study was to develop a sit-to-stand transfer assistive device, and to conduct a feasibility test.

Design: A technical note.

Methods and results: In this study, we developed a sit-to-stand transfer assistive device for the elderly and the disabled who have difficulty standing up independently from sitting positions. The sit-to-stand transfer assistive device allows the user to transfer the weight from a sitting position to a standing position while shifting the weight forward by grabbing and pulling a support stand. Ten healthy adults participated in the feasibility test of the device. Each participant used the developed sit-to-stand transfer assistive device and investigated supplementation through a brief interview. As a result of the feasibility test, the opinion was that the device could assist the sit-to-stand transfer to some extent. There were opinions that it needed a function to adjust the height of the knee protective plate in the sitting position according to the user's physical characteristics. Because of the inconvenience of operating the lock device for fixing the position and adjusting inclination, there was an opinion that the improvement for a locking device is needed. There were opinions that it would be better to reduce the size of the device due to its inconvenience of portability.

Conclusion: In this study, we developed the sit-to-stand transfer assistive device for the elderly and the disabled who have difficulty standing up independently from sitting positions. In addition, it is considered that the upgrade of the device is necessary for the future since there are supplementary opinions on some points.

Key words: Assistive device, Disabled, Elderly, Sit-to-stand transfer.

Corresponding author
Prof. GyuChang Lee
Kyungnam University, 7 Kyungnamdaehak-ro, Masanhappo-gu, Changwon, Gyeongsangnam-do, Republic of Korea
T: 055-249-2739, **E**: leegc76@hanmail.net

Received 2021-07-22 / Revised 2022-01-17 / Accepted 2022-03-03

Ⅰ. Introduction

According to the statistics of the elderly in 2020 released by the National Statistical Office, Korea is expected to enter a super-aged society, as the population aged 65 and over accounted for 15.7% of the total population in 2020 and will increase to 20.3% by 2025 due to rapid aging. In addition, the number of disabled registered by the Ministry of Health and Welfare in Korea (as of the end of December 2019) was about 2.61 million, or about 5% of the total population. Among them, the physically challenged person was surveyed the most with approximately 1.22 million (Statics Korea, 2020).

In old age, bodily functions deteriorate to general weakness such as muscle strength weakness, decreased sensory function, balance and gait ability due to geriatric disease and degenerative disease, etc (Baker et al., 2005). As a result of this deterioration of physical function, there is a limitation in the sit-to-stand transfer, which is the most basic movement of daily life.

The sit-to-stand transfer is one of the most performed movements in daily life and is very important in terms of activity-based functionalities (Smith & Baer, 1999). Although sit-to-stand transfer requires muscle strength and balance ability of the lower extremity, the frail elderly and disabled have difficulty performing sit-to-stand transfer due to the significant decrease in this ability (Lomaglio & Eng, 2005). And then it on affects increasing the risk of falls (Connell et al., 1997).

Because degenerative diseases and physical function limitations of the frail elderly and disabled require long-term rehabilitation treatment, most of them are cared for by a caregiver (Jumisko et al., 2005). Care involves of several activities that use the body excessively, such as lifting, standing, transfer, position change, and waist bending, while directly in contact with the participant (Connell et al., 1997). As a result, it often places a burden on the musculoskeletal system, which increases the risk of work-related musculoskeletal disease (Kwon & Yang, 2013). The prevalence of musculoskeletal injury among caregivers working in long-term care hospitals was quite high, and 90.8% of the caregivers responded that they felt pain while nursing care (Ryu, 2012).

Therefore, interest in devices to assist the sit-to-stand transfer for the frail elderly and disabled has begun to increase. Several devices have been developed to assist with the sit-to-stand transfer (Kim et al., 2009; Kim et al., 2015; Ahrary et al., 2018). Such devices should be easily and conveniently used by the frail elderly and the disabled who have difficulty in the sit-to-stand transfer due to lower extremity problems. It should also help prevent musculoskeletal diseases caused by excessive activities of caregivers.

For this purpose, a device was developed to assist the sit-to-stand transfer, and the feasibility of the device was briefly investigated in this study.

Ⅱ. Methods and results

1. Development of sit-to-stand transfer assistive device

1) Device structure

The sit-to-stand transfer assistive device consists of a movable part, a support stand, and a connective part connecting the two (Figure 1).

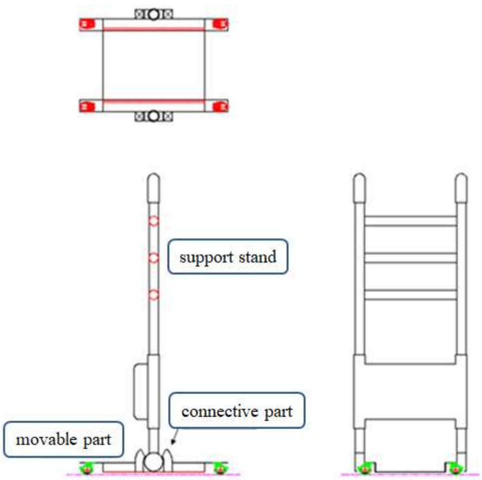

Figure 1. Concept of sit-to-stand transfer assistive device

The movable part has four wheels so that it can be moved after standing up, and the support stand has a structure of two columns so that the user can hold it with his or her arms when standing up. The connective part is adapted to fix the support stand with the movable part or to change the angle of the support stand. (Figure 2).

Figure 2. Sit-to-stand transfer assistive device

2) Device Operational algorithms

First, the device is positioned where the user sits, and the user's knee is supported by a knee protective plate of a support stand. When the user stands up actively, the angle of the support stand is fixed to the caregiver's side, and the user directly grabs the handle of the support stand and pulls the weight with the pulling force. By moving forward and upward, the user can stand up stably with little force. When the user stands up passively, the angle of the support stand is fixed to the user's side so that the user holds and maintains the handle of the support stand. And then the caregiver changes the angle of the support stand back to the caregiver's side and moves the user's weight upwards and forwards as well so that the user gets up easily from a sitting position.

2. Feasibility test

1) Participants and methods

In this study, a feasibility test of the sit-to-stand transfer assistive device was conducted on 10 healthy adults. After having the participants use the developed sit-to-stand transfer assistive device, a short interview was conducted to investigate the device's feasibility (Figure 3). The subjects were asked what was inconvenient about the device when using the sit-to-stand transfer assistive device.

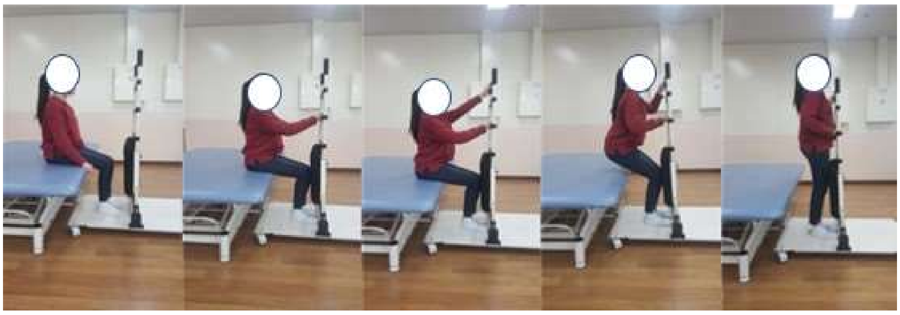

Figure 3. Feasibility test of sit-to-stand transfer assistive device

2) results

As a result of the feasibility test, overall was satisfied with the assistance degree of the sit-to-stand transfer assistive device when standing up from a sitting position. However, there were opinions that the sit-to-stand transfer assistive device needed a function to control the height of the knee protective plate in a sitting position according to the user's physical characteristics. Because the lock device for fixing the position and adjusting the inclination of the support stand was in the lower connective part, it was difficult to operate it, and there was the inconvenience of having to operate both sides at the same time. For this reason, there was an opinion that it needed to be improved to a locking device that could be easily manipulated. There were opinions that it would be better to reduce the size of the device as it would be inconvenient to move and store it because it was too large.

Ⅲ. Discussion

Due to natural aging or disease, the frail elderly and disbled with lower extremity muscle weakness have different sit-to-stand transactions from healthy adults (Park et al., 2003; Bernardi et al., 2004; Cheng et al., 2004). Stability during sit-to-stand transfer shows the individuality of movement according to the characteristics of an individual's physical disease (Bernardi et al., 2004; Ramsey et al., 2004; Roy et al., 2006). The sit-to-stand transfer is essential for the independent performance of basic activities of daily living. In the case of the frail elderly with weakened muscle strength and postural instability, the performance of sitting and standing motions is not independent and increases the risk of falls (Guralnik et al., 1994; Hirvensalo et al., 2000).

Several forms of sit-to-stand transfer devices have been developed for the frail elderly or disabled who have difficulty in sitting-to-stand transfer (Kim et al., 2009; Kim et al., 2015; Ahrary et al., 2018). In most cases, the sit-to-stand transfer devices are performed by adjusting the angle of the seat plate that supports the hips in the sitting position. Because they have only a slightly assistive function, it is difficult for the frail elderly and the disable to sit-to-stand transfer due to a severe decrease in the muscle strength of the lower extremity, and then they have limitations in use. In addition, since there is no function to support or assist other parts of the body such as an arm, there may be a risk that a fall may occur during the sit-to-stand transfer. In this study, we developed the sit-to-stand transfer device that enabled users to sit-to-stand transfer as easily and reliably as possible by holding the handle of a fixed support stand and moving the weight forward and upward.

In this study, the feasibility of the developed sit-to-stand transfer assistive device was investigated with a simple interview with healthy adults. As a result, they were generally satisfied with the device's sit-to-stand transfer assist. The frail elderly are difficult to sit-to-stand transfer because degradation of neuromuscular factors is combined with sensor-motor systems due to aging, etc (Kuh et al., 2006). Their difficulty in sitting-to-stand transfer increases the risk of falls (Orr et al., 2006). These falls can lead to serious injuries, and the fear of falling may limit the ability to perform activities in daily life (Hornyak et al., 2013). Stable performance of sit-to-stand transfer is important to prevent falls and improve quality of life.

As a result of the feasibility test, the participants were generally satisfied with the function of assisting the device's sit-to-stand transfer. Therefore, the frail elderly with reduced muscle strength and balance can use this device to sit-to-stand transfer, prevent falls, and expect a higher quality of life. In addition, it will also reduce the incidence of musculoskeletal disease in caregivers because caregivers can assist in sit-to-stand transfers of the frail elderly or disabled.

However, it is necessary to add a function for manipulating the height of the knee protective plate in a sitting position according to the user's physical characteristics. Since a locking device for fixing the position and adjusting the inclination of the support stand is located on the lower connective part, it is difficult to operate, and it is inconvenient to operate both sides at the same time. There were opinions that it needs to be improved into a locking device that can be easily manipulated and it would be better to reduce the size because the device is too large to move and store. In addition to supplementing this point in the future, the feasibility test will also need to be conducted on elderly or disabled users to clearly verify the feasibility of this device using quantitative methods.

References

Ahrary A, Yang WS, Inada M, et al. Development of the lift assist chair for the elderly people “Rakutateru”. Procedia Comput Sci 2018;131:31-7.

Baker DI, King MB, Fortinsky RH, et al. Dissemination of an evidence-based multicomponent fall risk-assessment and -management strategy throughout a geographic area. J Am Geriatr Soc 2005;53(4):675-80.

Bernardi M, Rosponi A, Castellano V, et al. Determinants of sit-to-stand capability in the motor impaired elderly. J Electromyogr Kinesiol 2004;14(3):401-10.

Connell BR, Wolf SL. Environmental and behavioral circumstances associated with falls at home among healthy elderly individuals. Atlanta FICSIT Group. Arch Phys Med Rehabil 1997;78(2):179-86.

Cheng PT, Chen CL, Wang CM, et al. Leg muscle activation patterns of sit-to-stand movement in stroke patients. Am J Phys Med Rehabil 2004;83(1):10-6.

Guralnik JM, Winograd C. Physical performance measures in the assessment of older persons. Springer; 1994.

Hirvensalo M, Rantanen T, Heikkinen E. Mobility difficulties and physical activity as predictors of mortality and loss of independence in the community-living older population. J Am Geriatr Soc 2000;48(5):493-8.

Hornyak V, Brach JS, Wert DM, et al. What is the relation between fear of falling and physical activity in older adults? Arch Phys Med Rehabil 2013;94(12):2529-2534.

Jumisko E, Lexell J, Söderberg S. The meaning of living with traumatic brain injury in people with moderate or severe traumatic brain injury LWW; 2005.

Kim HJ, Yeo HJ, Kim SS, et al. Development of non-motorized lifting chair for the elderly. J Soc Korea Ind Syst Eng 2015;38(4):226-32.

Kim JH, Hong JS, Chun KJ, et al. The development of lift chair for older adults' safety. J Ergon Soc Korea 2009;28(4):161-6.

Kuh D, Hardy R, Butterworth S, et al. Developmental origins of midlife physical performance: evidence from a British birth cohort. Am J Epidemiol 2006;164(2):110-21.

Kwon J, Yang M. A job analysis of acute care hospitals' formal caregiver. J Digital Convergence 2013;11(10):639-51.

Lomaglio MJ, Eng JJ. Muscle strength and weight-bearing symmetry relate to sit-to-stand performance in individuals with stroke. Gait Posture 2005;22(2):126-31.

Orr R, de Vos NJ, Singh NA, et al. Power training improves balance in healthy older adults. J Gerontol A Biol Sci Med Sci 2006;61(1):78-85.

Smith MT, Baer GD. Achievement of simple mobility milestones after stroke. Arch Phys Med Rehabil 1999;80(4):442-7.

Statics Korea. Life Tables [In Korean]. https://kosis.kr/. 2020.

Park ES, Park CI, Lee HJ, et al. The characteristics of sit-to-stand transfer in young children with spastic cerebral palsy based on kinematic and kinetic data. Gait Posture 2003;17(1):43-9.

Ramsey VK, Miszko TA, Horvat M. Muscle activation and force production in Parkinson's patients during sit to stand transfers. Clin Biomech (Bristol, Avon) 2004;19(4):377-84.

Roy G, Nadeau S, Gravel D, et al. The effect of foot position and chair height on the asymmetry of vertical forces during sit-to-stand and stand-to-sit tasks in individuals with hemiparesis. Clin Biomech (Bristol, Avon) 2006;21(6):585-93.

Ryu J. Prevalence of musculoskeletal symptoms and their related factors among care givers in long-term care hospitals. Graduate school of public health. Kyungnam. Inje University Press; 2012.