Kawasaki Journal of Medical Welfare Vol. 25, No. 2, 2020 29－34

Original Paper

Influence of the Use of Transfer Aid on Muscle Activity during Standing Motion Assistance

Yasuyuki NAGATA[*1], Kenichi KOBARA[*1], Katsushi KUNIYASU[*1], Daisuke FUJITA[*1], Tadanobu SUEHIRO[*1], Hisashi TAKAHASHI[*1] and Hiroshi OSAKA[*1]

(Accepted November 25, 2019)

Key words: transfer aid, muscular activity, standing motion assistance

Abstract

The purpose of this study was to examine whether the physical burden on the caregiver can be reduced by using a small and simple transfer aid instead of a manual lift. Fourteen healthy adult males participated in this study. The experimental conditions were analyzed with and without the use of the transfer aid. The muscle activity of the care-giver, while in the standing motion, was measured using a surface electromyogram during a patient transfer from the time at which the patient was seated until the time at which the patients buttocks departed the surface. The target muscles were biceps brachii, erector spinae, rectus femoris, and triceps surae muscles of the right side. The amount of muscle activity in the biceps brachii and rectus femoris was found to be significantly lower when using a transfer aid. The results of this study suggest that the transfer aid can reduce the physical burden in the relatively small muscle groups of the upper and lower limbs.

1. Introduction

Transfer assistance incorporates vertical and horizontal movement while the weight of the person being assisted is supported by the personnel, with a large physical burden placed on the extremities and trunk of the assisting personnel. In particular, standing-motion assistance, which is a procedure that lifts a person against gravity, is one of the physically burdening factors, with a high daily frequency during daily care operations. The number of daily transfers carried out by care staff working in geriatric health facilities varies depending on the work load and time of shift. On average, the frequency is high, with studies suggesting 18.6 transfers carried out by staff; therefore, transfer assistance is considered a factor of physical burden[1].

In recent years, the concept of "no lifting policies" due to transfer assistance causing a heavy physical burden is spreading, and the use of movable transfer aids is being recommended, such as floor traveling lifts and ceiling traveling lifts, to mitigate danger and pain associated with healthcare provision[2]. However, there are few facilities that possess transfer aids, and reports suggest that the usage rate is low in these facilities[3]. This is due to the extra time that is required and the reduction in work efficiency that occurs

[*1] Department of Rehabilitation, Faculty of Health Science and Technology, Kawasaki University of Medical Welfare, Kurashiki, 701-0193, Japan
E-Mail: nagata@mw.kawasaki-m.ac.jp

when aids are used[4]. Furthermore, large transfer aids have not been widely used in Japan due to space constraints and many caregivers tend to prefer a transfer utilizing the efficiency of human power only.

Therefore, the purpose of this study was to examine whether the physical burden on the caregiver can be reduced by using a small and simple transfer aid instead of a large lift.

2. Methods

2.1 Participants

The participants included fourteen healthy males (mean age: 20.8 ± 0.4 years, height: 169.6 ± 6.2 cm, weight: 62.6 ± 9.4 kg). For consistency, the same 22-year-old male (height 175.0 cm, weight 71.0 kg) was used as the patient being transferred. Participants provided written, informed consent prior to inclusion in the study. The study was approved by the Ethics Committee of the Kawasaki University of Medical Welfare (No. 18-024).

2.2 Measurements

Measurements were recorded with and without the use of a transfer aid. For the wheelchair transfer, the wheelchair was placed perpendicular to the left of a 45 cm-high chair without back support. The experimental conditions were as follows: non-use of the transfer aid involving the caregiver supporting the patient at their low back and between their legs, as shown in Figure 1. The transfer aid used in this study was the LIFTY-PI:VO (Energyfront, Okayama, Japan). The LIFTY-PI:VO consists of a seat cushion with a handle on either side and a belt that is used to strap the patient's knees together. The seat surface has excellent body-pressure dispersion and antibacterial properties and can be used as a seat cushion when not used for transfer. The belt provides a pivot point, which can be supported by the caregiver's knee (Figure 1). The patient was encouraged forward, and by applying care-giver body weight backward, a counterforce lifted the patient.

During the transfer procedure, the muscle activity of the care-giver in the standing motion was measured using a surface electromyogram (EMG) from the time at which the patient was in a seated position until the time at which the patient's buttocks departed from the surface. The point at which the patient's buttocks had lifted off the surface was confirmed using a pressure measuring device (GATE CODER, Anima, Japan). Muscle activity was measured using a wireless EMG (Vital Recorder 2; Kissei Comtec, Nagano, Japan). The target muscles were biceps brachii, erector spinae, rectus femoris, and triceps surae muscles on the right side. The landmarks of the electrodes were based on the work of Shimono[5]. After adequate skin preparation, surface electrodes (Blue Sensor N-00S, Medicotest A/S, Denmark) were applied parallel to the

Figure 1 Transfer aid (LIFTY-PI:VO)

In addition to the handle attached to the side of the seat cushion, this transfer aid is integrated with a belt that can be used to bind the knee joints of the person being assisted, making it easy to wear.

muscle fibers of the target muscles at a distance of 25 mm. A ground electrode was attached to the iliac crest. EMG data were bandpass-filtered (15-500Hz), and full-wave rectification was conducted. The average 0.5-second EMG amplitude was obtained from the point immediately after the patient's buttocks had departed from the surface. Furthermore, maximum voluntary contraction (MVC) of each target muscle was measured for 5 s, and the amount of activity of each muscle was calculated (Figure 2).

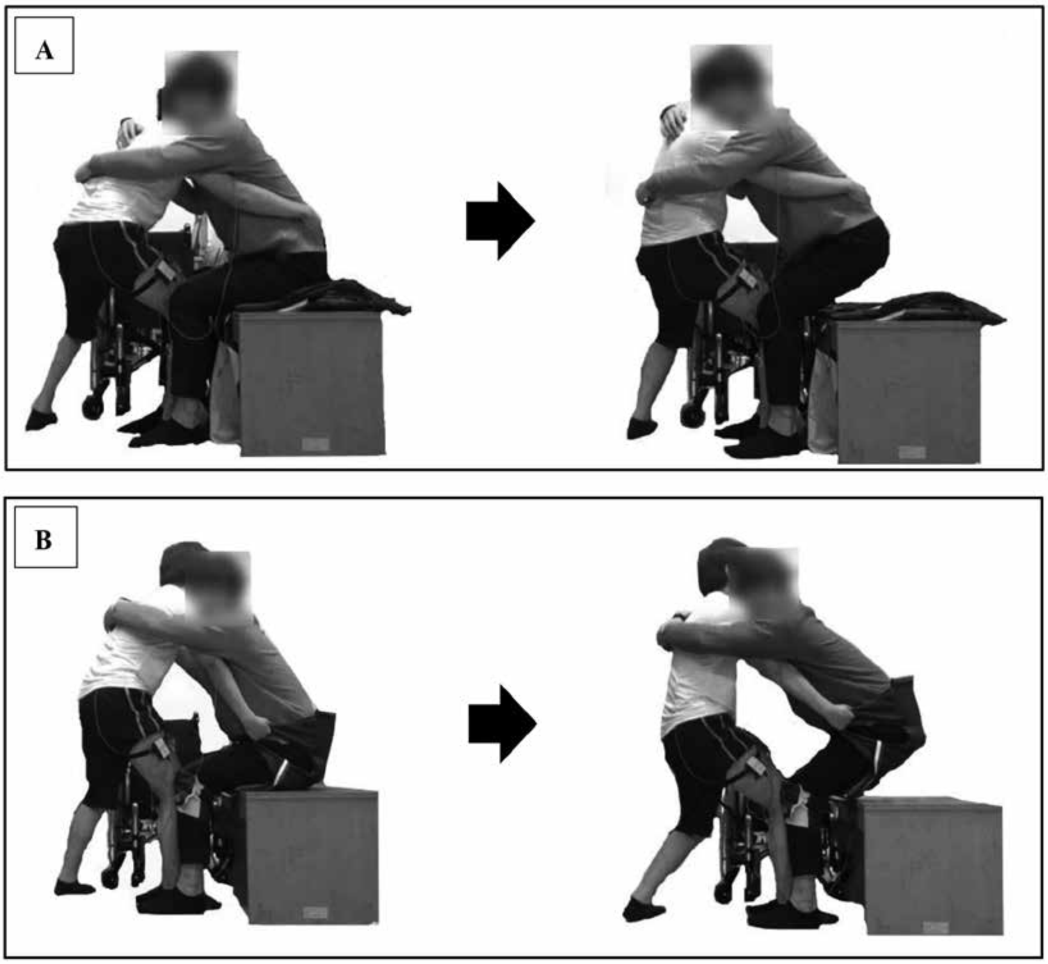

Figure 2 Experimental conditions

A: Conventional standing-motion assistance
B: Assisting standing motion using transfer aid

2.3 Statistical analysis

The distribution of the data was confirmed using the Shapiro-Wilk test. As the data was not normally distributed, the Wilcoxon signed rank test was used to compare muscle activity between the two conditions. The significance level was set at $p<0.05$. SPSS Statistics ver. 24.0 was used for all statistical analyses.

3. Results

The amount of muscle activity in the biceps brachii and rectus femoris muscles were significantly lower when using the transfer aid compared to that when the transfer aid was not used ($p<0.01$). However, there was no significant difference in the muscle activity of the erector spinae and triceps surae muscle groups between the two conditions (Table 1).

Table 1 Comparison of muscle activity between the patient transfer performed with the transfer aid and the transfer performed without the transfer aid

	Using the transfer aid (n=14)	Without using the transfer aid (n=14)
Biceps brachii	5.4 (1.8-23.9)	39.3 (27.7-41.0) **
Erector spinae muscle	20.5 (15.3-43.2)	36.3 (22.5-58.3)
Rectus femoris	7.4 (6.3-12.1)	16.4 (8.9-27.6) **
Triceps surae	31.4 (20.8-57.4)	30.3 (15.3-53.8)

Unit : % Values are median (interquartile range) ** : $p<0.01$

4. Discussion

This study found that a lower EMG activity is produced in the biceps brachii and rectus femoris muscle groups when performing a patient transfer with a transfer aid compared to that produced when the transfer aid is not used. When transferring patients from a bed to a wheelchair, the caregiver often holds and lifts the patient, exerting a large physical burden on the caregiver, predisposing them to musculoskeletal injury. Therefore, the use of transfer aids is recommended. However, in Japan, the idea that care should be performed by human hands is given priority, and manual handling equipment is not widely used in the clinical setting. In addition, large transfer aids have the disadvantage of occupying space and environmental improvements, and they require labor and time[4]. Therefore, in this study, we examined whether the physical burden on the caregiver can be reduced by using a simple transfer aid.

During the conventional standing-motion assistance, the burden on the biceps brachii is large as it is necessary to flex the elbow joint to support the patient and their bodyweight. The transfer aid used in this study is based on the lever principle (first class lever). The side handle that the caregiver holds is the point of load, the knee joints act as the fulcrum, and the center of gravity of the caregiver is the effort point. By having the effort point far from the fulcrum, the lift can be carried out with less force than the conventional method. Therefore, the transfer aid is considered to have significantly reduced the muscle activity of the biceps brachii due to extension of the elbow joint, and thus, increasing the distance of the caregiver's center of gravity from the fulcrum.

In addition, the conventional standing-motion procedure requires assistance to support the person's bodyweight and raise their center of gravity upward, and this further inhibits the patient from being able to move their center of gravity or tilt forward. Therefore, a large burden is exerted on the caregiver's lower limbs. However, utilization of the transfer aid requires less assistance for the upward lift, and it does not prevent the forward motion of the patient's center of gravity; therefore, the muscle activity of the rectus femoris was found to be lower. The differences in lower-limb activation between the two transfer methods is due to the utilization of a fulcrum at the knee joints (Figure 3).

During standing-motion transfers, the greatest physical burden is exerted onto the caregiver's lower back, which may predispose to injury and pain. With awareness of this potential lower back pain, caregivers may focus on avoiding pain, or they may attempt to reduce the physical burden place on this region by eliciting a poor quality lift or a pull technique. In addition, lifting a heavy object using the small muscles of the hands and arms causes greater fatigue in these muscles[6]. Moreover, this unreasonable assistance that is required may cause caregiver anxiety and discomfort, and a painful reaction may be observed[7]. Both the caregiver and the recipient must be comfortable, and it is important to minimize the muscle activity of the caregiver's smaller muscle groups. Therefore, the results of this study suggest that the transfer aid used in this study can suppress the muscle activity of relatively small muscle groups in the upper and lower limbs, and reduce the physical burden placed on the caregiver.

In the healthcare field, there is an ideology that movement assistance provision, like transfers, should be performed by human hands. It is difficult to change that work environment, and there are currently

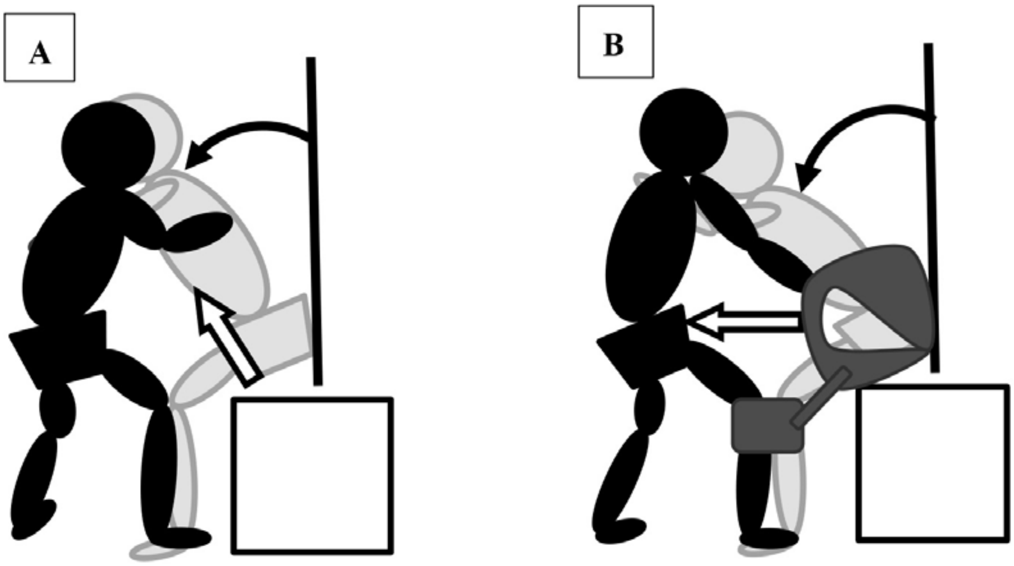

Figure 3 Posture difference immediately after the buttocks is lifted

A: During the conventional standing-motion assistance operation, in addition to pulling the patient toward the caregiver, assistance is required to move the center of gravity upward. B: By using the transfer aid, it is not necessary to assist with lifting.

minimal transfer aids, such as electronic lifts, available[8]. In addition, it is said that the use of a transfer board or an assistance belt, which is relatively inexpensive and easy to use compared to a manual lift, reduces the burden of assistance; however, its use is not sufficiently widespread[9,10]. This is due to the shortage in assistant manpower, and the positive effects of using a transfer aid, such as a transfer board, is not clearly demonstrated to medical welfare workers[11]. Furthermore, it is thought that transfer aids are a major time constraint in terms of preparation and use. The advantage of the transfer aids in this study is that is can to be used as a patient cushion and can be turned into a transfer aid by simply applying a knee belt. The transfer aid utilized in this study was found to reduce the muscle activity of some upper and lower limb muscle groups, and it can be utilized as an effective method to transfer patients.

Conflict of interest

The authors declare no conflicts of interest.

References

1. Saijo F, Minejima T, Sugita H, Yamazaki K, Furuya M and Abe N : Frequency and time required for transfer assisting activities in a health facility for the elderly. *Journal of Physical Therapy Science*, **15**(4), 181-186, 2000. (In Japanese with English abstract)
2. Nakayama S : No lifting movement, transfer technology. *Journal of Fureai Care*, **19**(13), 12-17, 2013. (In Japanese, translated by the author of this article)
3. Iwakiri K, Takahashi M, Sotoyama M, Hirata M and Hisanaga N : Usage survey of care equipment in care service facilities for the elderly. *Journal of Occupational Health*, **49**(1), 12-20, 2007. (In Japanese with English abstract)
4. Motegi N, Yasuda S and Misawa T : Experimental study of assistant aids and a new nursing method in nursing care work. *Journal of Science of Labour*, **88**(3), 81-93, 2012. (In Japanese with English abstract)
5. Shimono T : *SEMG clinical application manual*. SAKAI Medical, Tokyo, 2010. (In Japanese, translated by the author of this article)
6. Ogawa K : Mitigation measures for lower back burden from the caregiver's side. *Digest of Science of*

Labour, **52**(5), 276-279, 1997. (In Japanese, translated by the author of this article)

7. Itami K, Yasuda T, Toyoda K, Ishida H, Kurushima M, Fujita K, Tanaka K and Moriwaki K : Evaluation of human physical and mental burdens regarding standing transfer in individuals with reduced lower limb strength. *Journal of Human Nursing Studies*, **3**, 11-21, 2006. (In Japanese with English abstract)
8. Tomioka K, Kumagai S, Kosaka H, Yoshida J, Tabuchi T, Kosaka J and Arai Y : Equipment at the special nursing homes for the elderly: A workplace survey of new nursing homes in Osaka Prefecture. *Journal of Occupational Health*, **48**(2), 49-55, 2006. (In Japanese with English abstract)
9. Sasaki H, Katsuhira J, Watanabe H, Saijou F and Saitou A : Low back load of caregiver during transfer movement using assistive devices. *Japanese Physical Therapy Association*, **34**(7), 294-301, 2007. (In Japanese with English abstract)
10. Katsuhira J, Sasaki H and Maruyama H : Evaluation for the effect of using assistive devices on person-transferring tasks. *Journal of the Society of Biomechanisms*, **19**, 233-242, 2008. (In Japanese with English abstract)
11. Katsuhira J, Tomita S, Haraguchi T, Harada S, Ishikawa E, Kubo K and Maruyama H : Effect of use and type assistive devices and posture while using them on the low back load in transferring tasks. *The Japanese Journal of Ergonomics*, **46**(2), 157-165, 2010. (In Japanese with English abstract)