Analysis of moment using different type of hand grips of parallel bars-one side support in sit-to-stand motion

Keio Ishiguro*[1)], Yukio Kurukawa[1)], Naritoshi Sato[1)], Yoshihiro Ehara[2)], and Kaoru Abe[2)]

Key words : Different type of hand grips, Sit-to-Stand movement,
One side support in parallel bars

Introduction

Movement of body in sit-to-stand (STS) is an important study subject because it is indispensable in standing up from chair, bed and toilet and to walk during everyday activity, throughout one's life. Generally, we use parallel bars when we start exercises of STS in Rehabilitation.

Hand gripes on parallel bars are either round type (Round) or flat type (Flat).

Some studies have been carried out on movement in STS using both parallel bars.

However, only a few studies have been carried out using one sided support which is often observed in case of hemi paralysis for patients with cerebrovascular accidents (CVA).

The purpose of this study is to investigate the difference of type of hand grips in STS and to recommend a proper choice in Rehabilitation.

Material and methods

Six healthy male students participated in this study. The mean value and standard deviation of age, height and of weight were 22 years, 169cm and 58.6kg respectively.

Prior to start the study, the purpose and procedures of this study were explained to every subject in detail and informed written consent was obtained. There were two methods employed in this study.

Method 1

Subjects stood up from a chair using parallel bars. Start position was taken with the angle of knee joint at 90 degree flexion and of ankle joint at 0 degree dorsiflexion.

Subjects were to use of the one side parallel bar grasping with the right hand (normal side for left hemiplasia). Then, they stood up with partial weight on their left foot. they used two different types of handgrip on parallel bars. The two kinds of handgrip-bars used were round type (Round) and flat type (Flat). In addition, grasping at two different positions on parallel bars are shown in the figures and are categorized as experiment procedures (fig.1).

Round A shows useing round hand grip and standing up with right hand beside trunk on the parallel bar. Round B shows using round hand grip and standing up with right hand above knee on the parallel bar. Flat A shows using flat hand grip and standing up with right hand beside trunk on the parallel bar. Flat B shows using flat hand grip and standing up with right hand above knee on theparallel bar (fig.1).

These measurements were repeated three times. They practiced this movement several times, until they could move as directed as shown in the figures.

Method 2

We used VICON MX system for analysis of

[1)] Department of Physical Therapy, Niigata University of health and Welfare, Shimami-cho, Kitaku, Niigata-shi, 950-3198, Japan
[2)] Department of Prosthetics and Orthotics and Assistive Technology, Niigata University of Health and Welfare, Shimami-cho, Kitaku, Niigata-shi, 950-3198, Japan

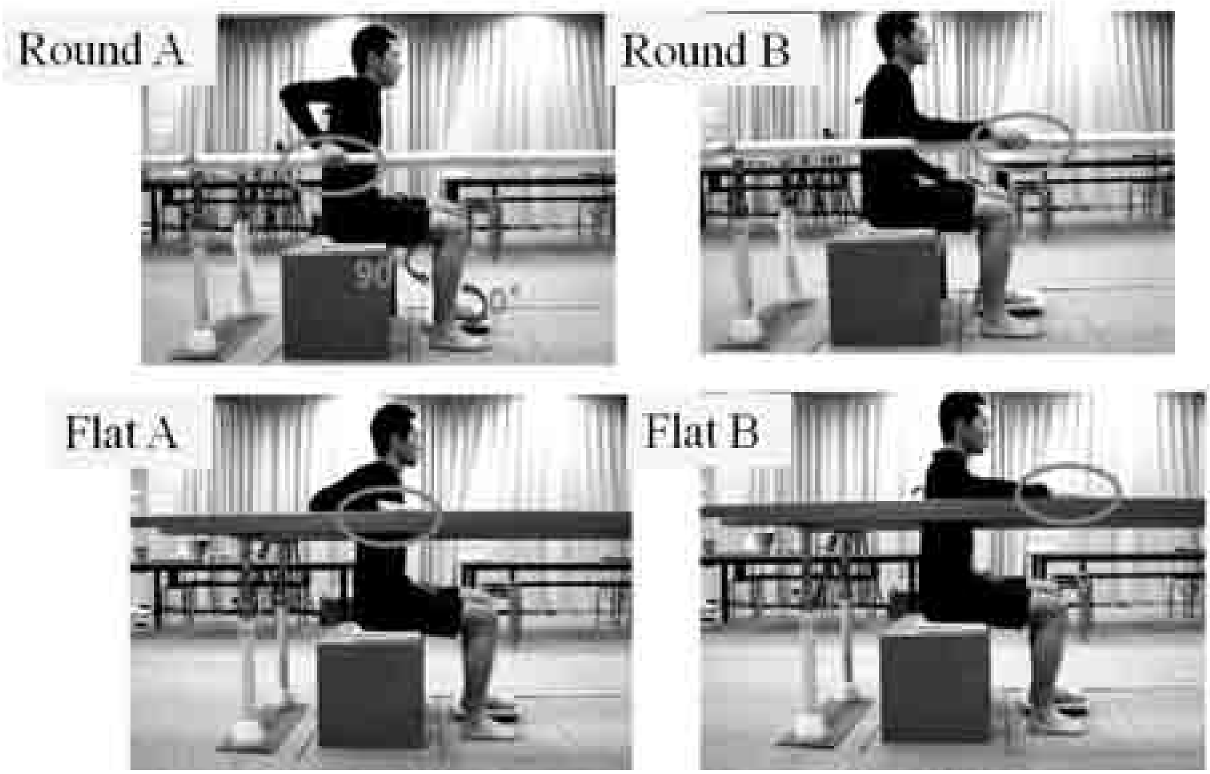

Fig.1 How to stand up from a chair

three dimensional movements. Sampling frequency was 100Hz. This system has 9 infrared cameras and 6 force plates. There are 15 markers for each subject. The position of makers are set at the following five positions : at bilateral acromion, tip of elbow, styloid process of radius, a line of one third of distance from bottom anterior superior iliac spine and greater trochanter, lateral epicondyle of femur, lateral malleolus, head of 5th metatarsal and one point at right side posterior superior iliac spine.

Disposable bipolar electrodes were attached to the skin over each muscle, using adhesive gel. The distance between the centers of electrodes was placed on the midline of muscle belly with the direction along the longitudinal muscle fibers. Surface EMG signals of the muscles were recorded while subject was moving, standing up from chair, to steady standing position. Disposable electrodes were attached on right side of biceps brachii, triceps brachii and brachioradialis muscle. EMG sampling frequency was 1000Hz. RFEMG stands for Rectified Filtered Electromyography. In this method, the potential obtained was converted to 100Hz to make of acceptable to VICON system

The measurement of RFEMG used Band pass filter at 10 Hz from 1000Hz and the data of RFEMG was recorded in a personal computer (fig.2).

The data of RFEMG was taken as the average at maximum isometric contraction within one second.

Each muscle was measured for the average at maximum isometric contraction of RFEMG and this value was taken as 100% and used for normalization. The data of joint-moments was calculated from DIFF (software for computer). The data of joint-moments were recorded while subject was moving from chair to steady standing

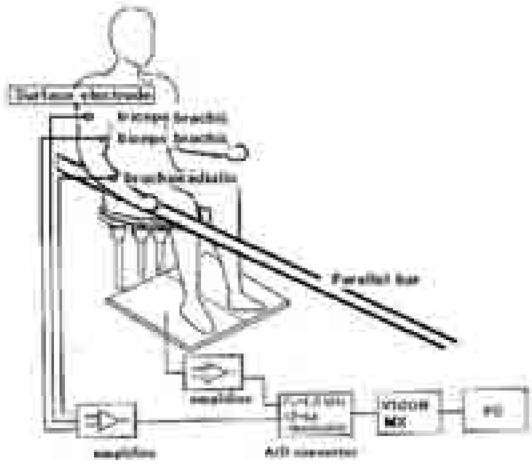

Fig.2 Recording and data analysis using EMG

position as explained earlier. The maximum value from the data of %RFEMG and joint-moments was presented. Statistics were obtained from Wilcoxon's rank sum test (two tails).

Results

Fig.3 shows %RFEMG of upper limbs. In comparison of biceps brachii, Round A was larger than Flat B. Round B was larger than Round A. Round B was larger than Flat A. Flat B was larger than Flat A. In comparison of brachioradialis, Round B was larger than Flat B. Round B was larger than Flat A. In comparison of triceps brachii, Flat A was larger than Round A. Round A was larger than Flat B. Flat A was larger than Round B. Fig.4 shows moments of lower limbs. In comparisons of moments of hip for extension, Round A was larger than Flat A. Flat B larger than Flat A. In comparisons of moment of knee for extension, Flat B was larger than Round A. Round B was larger than Round A. Round B was larger r than Flat A. Flat B was larger than Flat A. In comparisons of moments of ankle for dorsiflextion, Flat B was larger than Round A. Flat B was larger Round B.

Discussion

In left hemi paralysis for patients with CVA, with generally stand up from chair using parallel bars with one-side-support, and start to pull the bar right biceps brachii and brachioradialis.

And one's trunk is inclined forward with increasing moment for right dorsiflexion. Next, his buttock leaves the chair, and weight begins to increase on the feet. At that time, his moments for hip and knee extensions are at the maximum. Finally, %RFEMG of triceps brachii is at the maximum with help from knee and hip extension moments.

1. About %RFEMG of biceps brachii.

Biceps brachii muscle begins to be activated before the time when the buttocks off (Fig.5). These functions are to pull on the grip for his body with brachioradialis muscle after thetime when the buttocks off. And he can use it efficiently to pull his body when grasping the grip of parallel bar. And muscular strength increases when muscle are stretched. Therefore, Round B is the largest in four conditions.

2. About %RFEMG of brachioradialis.

Brachioradialis muscle begins to be activated at the time when the buttocks is off, with biceps brachii (Fig.5). The function of this muscle is to pull his trunk forward. Round handgrip-bar is more convenient to grasp than Flat type for the subject.

3. About %RFEMG of triceps brachii (fig.5).

Triceps brachii has the function of elbow extension. This muscle is activated with hip muscles and knee muscles for extension in this case. However, this muscle moved after his hip and knee moments for extension. This muscle's function is to extend his body at the final point.

I suggest that the flat type grip can efficiently bear his weight. Therefore, flat-grip near his body position is able to bear his weight.

4. About hip and knee joint moment for extension.

It is recognized that the flexion has occurred, in the position holding the parallel bar to lift trunk and be flexed, while he pulls his trunk forward by bending his body. As the holding position of

%RFEMG	(%)
biceps brachii	
Round A	2.80±0.83
Round B	6.72±2.72
Flat A	2.55±0.93
Flat B	5.58±2.49
brachioradialis	
Round A	11.49±6.05
Round B	19.09±11.11
Flat A	8.75±2.91
Flat B	9.94±4.34
triceps brachii	
Round A	28.09±7.66
Round B	18.99±16.60
Flat A	31.57±9.06
Flat B	25.09±17.86

Fig.3 %RFEMG of upper limb

Hip joint　Moment for extention	
Round A	31.83±3.85
Round B	38.07±17.06
Flat A	23.39± 5.77
Flat B	34.69± 6.53
Knee joint　Moment for extention	
Round A	36.37±16.54
Round B	56.16± 6.76
Flat A	39.51± 10.26
Flat B	58.42± 7.59
Ankle joint　Moment for dorsiflextion	
Round A	5.02 ±2.84
Round B	5.22± 3.14
Flat A	4.03 ± 5.42
Flat B	7.17 ± 1.80

Fig.4 Joint moments of lower limb

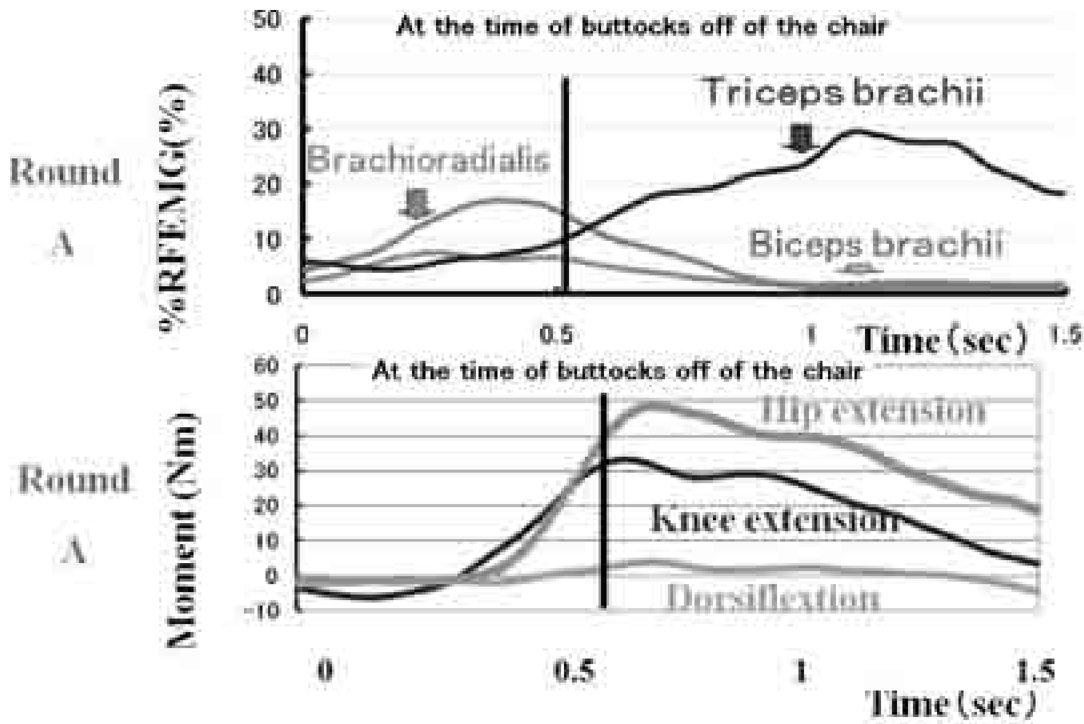

Fig.5 %RFEMG and moment data from one person at condition of Round A

parallel bar moves further away from his trunk, his moment to extend his hip and knee increases. The joint moment of upper limb increased, when one holds the bar near his trunk.

As to difference of hand grips, I suggest that one can move easily bearer his weight on a type of flat grips and near his body from his right hand.

5. About ankle joint moment for dorsiflextion.

More body flexion degree is needed to stand up from chair with a flat grip than round grip. I can be seen that one needs more moment for dorsiflection as one's holding position of parallel bar moves further away from one's trunk.

Conclusion

1. We have analyzed the movement of presumptive single paralytic patients by using one side of parallel bars. In this study, two different types of hand grips are used to stand up using parallel bars, in addition to changing the hand position when grasping the parallel bar.
2. As to %RFEMG of upper limb, Round B is the largest of all positions concerning biceps brachii and brachioradialis muscles. I suggest that biceps brachii and brachioradialis muscles function to pull one's body and the grip of round type is more easily grasped using parallel bar than flat type. Activity of triceps brachii of Flat A is the largest of all conditions. I think that the type of flat hand grip is better to bear his weight than round type.
3. As to joint moments of lower limb, hip and knee joint moments for extension, theses moments are increased the further from the body the hand is positioned. The center of gravity on one's body moves forward.
4. In the rehabilitation of hemi paralysis for patients with CVA, the flat type of hand grip is better to use because it does not to pull one's body.

References

1) Ehara, H., Yamamoto, S., Analyses of movement in sit-to-stand, Entrance of Body Dynamics, Ishiyaku Publishers, 2-81, 2001.
2) Katuhira, S., Yamamoto, S., Analyses of joint moment in standing up moment with hand rail, JSPO, 21-1, 45-51, 2005.
3) Maruta, K., The Influence of Seat angle on Forward Trunk Inclination during Sit-to-stand, JPTA, 31-1, 21-28, 2004.
4) Asakawa, Y., Itihashi, N., Electromyographic Analysis of Hip Muscles during Step-up Exercises, JPTA, 27-3, 75-79, 2000.
5) Mori A., Eguchi A., Watanabe S., Influence on the Differences in Chair Height of Standing Up and Down Movement on Electromyographic Activities in Lower Extremity Muscles., Kawasaki Medical Welfare Journal, 13-1, 169-171, 2003.
6) Kawaguchi A., Yamamoto M., Biomechanical Analysis on Usability of Vertical Handrail Assisting Standing-up Motion, J of Matsushita Electric Works, 76, 52-57, 2001.
7) Keio, Ishiguro., Kazuyoshi, Sakamoto., Influence of height of parallel bars on both muscular activity of lower limb during walk supported and vertical force to bottom of foot by parallel bars for healthy person and disabled person in cerebral blood vessel, Journal of Japan Society for Welfare Engineering, 8-1, 29-33, 2006.
8) Keio Ishiguro, Yoshihiro Ehara, Yukio Kurokawa, Kazuyoshi Sakamoto, Analysis of movement in sit-to-stands motion using parallel bars one-side support, The Niigata Journal of Health and Welfare, 5, 81-84, 2006.
9) Keio Ishiguro, Yukio Kurokawa, Yoshihiro Ehara, Kaoru Abe, Dynamic analysis of artificially induce stumbling gait, The Niigata Journal of Health and Welfare, 6, 95-101, 2007.