身体バランスの視点からみた腰部サポートウェアの効果

An Influence on Human Postural Balance of Waist Support Wear during Lifting Loads

○ 丁 憙勇（阪大）清水 咲希（阪大）渡辺 宗一郎（鴻池運輸）鳥飼 一男（鴻池運輸）林 雅信（鴻池運輸）

木戸 倫子（阪大）野村 泰伸（阪大）三善 英知（阪大）山田 憲嗣（阪大）大野 ゆう子（阪大）

Hieyong JEONG[1], Saki SHIMIZU[1], Soichiro WATANABE[2], Kazuo TORIGAI[2], Masanobu HAYASHI[2], Michiko KIDO[1], Taishin NOMURA[1], Eiji MIYOSHI[1], Kenji YAMADA[1], and Yuko OHNO[1]

[1] OSAKA University

[2] KONOIKE Transport Co., LTD.

Abstract: We have an interest in the relationship between the human postural balance and back injuries. Although back injuries are the number-one problem facing the workforce in the industry of carrying loads, there appears to be no firm idea on how this will deal with in practice. In this paper, we focus on evaluating how the human postural balance is affected by the waist support wear. We measure the center of balance during lifting loads with or without the waist support wear according to the time schedule. Through experiments, we found the influence on human postural balance of waist support wear. Namely, the center of balance is enhanced under the condition of waist support. And we can see that the tendency of subject for center of balance gets to be similar to that of expert by using the support wear. We show and discuss the experimental method and results.

Key Words: Human postural balance, Waist support wear, Lifting loads, Nintendo wii balance board, Center of balance

1. INTRODUCTION

In the industry of carrying loads, the number of patients with back injuries has been increasing every year. It is well known that the amount of weight you lift and the way you carry and move it play a big role in preventing a back injury, because the human body is not designed to lift heavy loads [1]. Thus, a lot of health service center suggest that certain actions are more likely to cause back injuries than other, accordingly anytime you find yourself doing one of these things; heavy lifting, twisting at the waist, reaching and lifting, and working in awkward, uncomfortable positions. However, as the result of Bureau of Labor Statistics in USA is shown, more than one million workers suffer back injuries each year, and back injuries account for one of every five workplace injuries. This means that material handling and lifting injuries are exceedingly painful, difficult to heal, and have an effect on everything you do [2]. Although back injuries are the number-one problem facing the workforce in the industry of carrying loads, there appears to be no firm idea on how this will deal with in practice. At this point, we start to have a question about the different possible factor for evaluating the motion carrying loads [3 ~ 6].

Focusing on the role of brain, the goal of this paper is to evaluate an influence on the human postural balance of waist support wear during lifting a load as shown in Fig.1. Accordingly, we focus on evaluating how the human postural balance is affected by the waist support wear with the function of power support. Namely, We measure the center of balance during lifting loads with or without the waist support wear according to the time schedule. A subject lifts an object as usual. While a subject stand up by lifting loads, the result of this experiment shows the center of balance during lifting a load. Through all of experiments, we found that the trace of center of balance is enhanced when a subject wear the waist support.

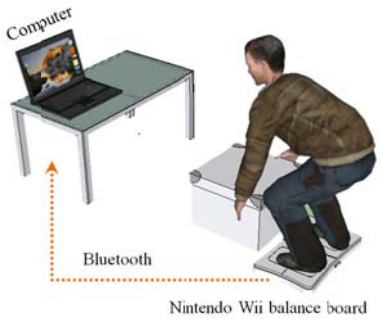


Fig. 1. An experimental overview for measuring the center of balance during lifting a load.

2. EXPERIMENT

Fig. 1 shows the total experimental system for evaluating the balance. The system consists of the Nintendo Wii balance board and the computer. The board uses Bluetooth technology and contains four pressure sensors that are used to measure the user's center of balance. The computer is used to get data from the balance board through Bluetooth, and then process data for calculating the center of balance [7]. Fig. 2 shows the flow chart for all of experiments. At first, a subject performs to lift loads from 6 kg to 18 kg without the waist support wear [8], and then does same things with the waist support wear. For deciding the steady state, the subject makes a stop during five seconds while measuring the center of balance. All of subjects are 20 ~ 40 years old, three males without any physical handicap.

Fig. 3 shows the experimental results of beginner at the weight of 18 kg. In this paper, a beginner indicates the

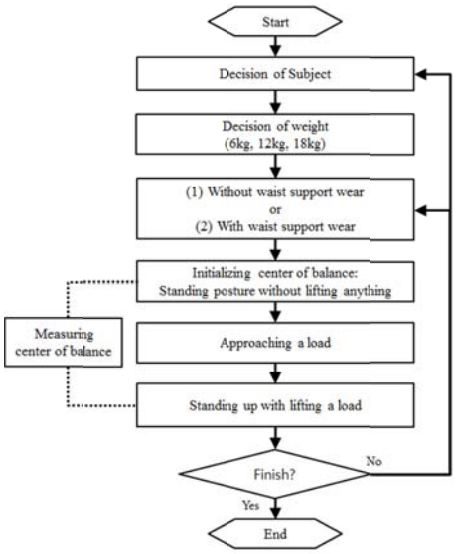


Fig. 2. The experimental flow chart.

man not to carry loads for living. Fig. 3 (a) represents under the normal condition, and Fig. 3 (b) represents under the condition with the waist support wear, respectively. The point of (0, 0) means the center of balance for standing state as initialization. Although a subject has any swing motion during lifting a load without the waist support wear, we can see that the center of balance is enhanced under the condition with the waist support wear. The subject also has the feeling for power support.

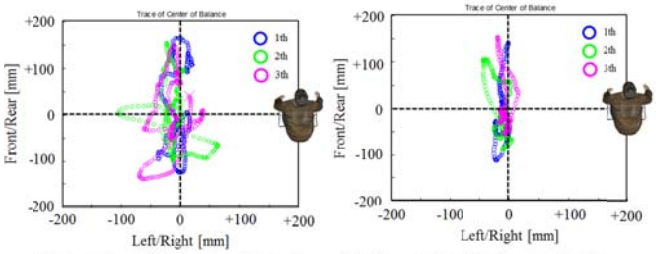
As a result, we confirmed the influence on the human postural balance of waist support wear during lifting a load.

3. DISCUSSION

Fig. 4 shows the experimental results of expert at the weight of 18 kg. In this paper, an expert indicates the man to carry loads for living. Fig. 4 (a) represents under the normal condition, and Fig. 4 (b) represents under the condition with the waist support wear, respectively. We can see that an expert doesn't have a big enhancement with the waist support wear because he has the good experimental results without the support wear originally. However, when you compare the results of Fig. 3 (b) with the results of Fig. 4 (a), you can see that the tendency of beginner for the center of balance is similar to that of expert. This influence comes from the waist support wear. The waist support wear help a subject to lift a load with some power support. The power support comes from the length change of elastic material, namely, elastic restoring force. Through all of experiments, we can see that the elastic restoring force is useful for the human postural balance.

4. CONCLUSION

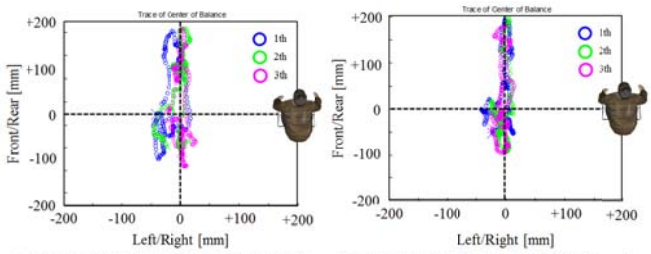
We evaluate how the human postural balance is affected by the waist support wear. We measure the center of balance during lifting loads with or without the waist



(a) The results of beginner without the waist support wear at the weight of 18kg.

(b) The results of beginner with the waist support wear at the weight of 18kg.

Fig. 3. The experimental results of beginner under the condition of waist support wear.



(a) The results of expert without the waist support wear at the weight of 18kg.

(b) The results of an expert with the waist support wear at the weight of 18kg.

Fig. 4. The experimental results of expert under the condition of waist support wear.

support wear according to the time schedule. Through all of experiments by using Nintendo Wii balance board, we confirmed the influence on the human postural balance of waist support wear during lifting a load. And then the tendency of beginner for the trace of center of balance gets to be similar to that of expert by using the waist support wear.

REFERENCES

(1) Health Services Tang Center, *Berkeley University of California*, http://uhs.berkeley.edu/facstaff/ergonomics/lifting/safelifting.shtml

(2) G. Beaudette, "Material Handling and Back Safety Training," Environmental Health, Safety, and Risk Management, *Oklahoma State University*, https://www.uaf.edu/files/safety/material_handling.ppt.

(3) H. Jeong, S. Shimizu, S. Watanabe, K. Torigai, M. Hayashi, M. Kido, T. Nomura, E. Miyoshi, K. Yamada, and Y. Ohno, "Experimental Evaluation of Human Postural Balance through Lifting Loads," *IEEE International Conference on Systems, Man, and Cybernetics (IEEE SMC 2014)*, Oct 5-8, 2014 (Accepted).

(4) Y. Asai, S. Tateyama, and T. Nomura, "Learning an intermittent control strategy for postural balancing using an EMG-based human-computer interface," *PLoS, Published online, doi: 10.1371/journal.pone.0062956*, vol.22, no.5, e62956, 2013.

(5) Y. Ouchi, H. Okada, E. Yoshikawa, S. Nobezawa, and M. Futatsubashi, "Brain activation during maintenance of standing postures in humans," *Oxford Journals, Brain*, vol.122, no.2, pp.329-338, 1999.

(6) R.D. Crowninshield and R.A. Brad, "A physiologically based criterion of muscle force prediction in locomotion," *Journal of Biomechanics*, vol.14, no.11, pp.793-801, 1981.

(7) Wii Balance Board, http://en.wikipedia.org/wiki/Wii_Balance_Board

(8) rakunie, http://www.morita119.com/study/health/rakunie.html