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圧力中心による回転ハンドリング動作の分析

Analysis of Center of Pressure during Asymmetric Lifting

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Abstract: We have an interest in the effect of pelvis location on asymmetric lifting. Although a lot of studies on forces on lumbar spine during the asymmetric lifting have been achieved, there was little study on the pelvis location during the asymmetric lifting. The main purpose of this study was to analyze the location of center of pressure (COP) between healthy workers (Group 1) and beginners (Group 2) during the asymmetric lifting. We performed experiments to move the 18kg load to the left side under the condition of closed eyes. Through analysis results of COP locations, we found that there was the big difference of COP during the rotation location between Group 1 and 2 with $p < 0.001$. We discussed the reason why this difference came from the different pelvis location between two different groups.
Key Words: Asymmetric lifting, Center of pressure, Force on lumbar spine, Pelvis location

1. Introduction

LBP is highly prevalent problem worldwide, with the point prevalence estimated at ~18% of the general population [1]. The financial burden of LBP in relation to health care costs and productivity loss is substantial. However, treatment of LBP presents a considerable challenge, as a specific pathoanatomical diagnosis cannot be identified in ~85% of cases [2]. A complex array of risk factors are known to contribute to the condition, such as increased age, female sex, low educational status, obesity, occupation and psychosocial factors [1]. Accordingly, we consider that the prevention through good lifting posture is the best way to reduce the high risk of LBP.

One team including 2~3 workers is usually in charge of one container at the real logistic workplace. Workers inside of the container rearrange all of boxes on the pallet, and the lifter outside of the container carries the pallet to a warehouse. The frequency to lift the box is one time forward bending per 30 sec, and one container should be finished within 2~3 hours. The temperature of inside container rises more than 40 degrees Celsius in summer. We can say that the environment of logistic workplace is harsh. Thus, it is well known that most of workers suffer from non-specific LBP [3]. Nevertheless, we wonder whether healthy workers have the distinguished difference of handling posture or not. If heathy workers show the difference of lifting posture, we have the possibility to adjust the incorrect lifting posture.

In this study, the main purpose was to analyze the location of center of pressure (COP) during the asymmetric lifting between healthy workers (Group 1) and beginners (Group 2). We consider that the COP location is changed by the pelvis location during the lifting. We performed experiments to move the 18kg load to the left side under the condition of closed eyes. Through analysis results of COP locations, we found that there was the big difference of COP location during the rotation between Group 1 and 2 with $p < 0.001$. We discussed the reason why this difference came from the pelvis location during the rotation in order to reduce forces on lumbar spine.

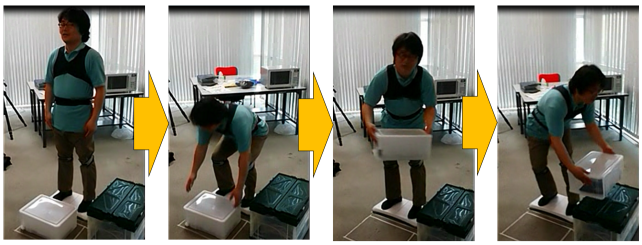


Fig. 1. An explanation of experimental procedure.

2. Method

Fifteen participants are healthy 20~50 years old; ten carrier workers of KONOIKE Transport Co., Ltd. with the career of 10~30 years (Group 1), and five beginners of Osaka University without any experience (Group 2). No participant reported a major back or lower limb pathology, use of medication, or a history of neurologic disease that may influence standing balance.

Fig. 1 shows an explanation of experimental procedure. The phase 1 is the step to stand on the Wii Balance Board (WBB) for calibrating the initial COP location. The phase 2 is the step to approach the load immediately before lifting. The phase 3 is the step to lift the load vertically. The phase 4 is the step to rotate the load to the 90 degree left table while lifting.

In this paper, we measure the COP during asymmetrical lifts. The COP indicates the orthogonal projection of the center of gravity (COG) including the weight and distance of participant and object to be lifted. Although it is difficult to measure the COG directly that is the value for three-dimensional space, it is possible to measure the COP directly that is the value for two-dimensional space by using the device like a WBB or force platform, etc.

Fig. 2 shows a schematic drawing of the experimental setup, showing the 0 and 90 degree asymmetry conditions. All of participants perform the experiment on the WBB in order to

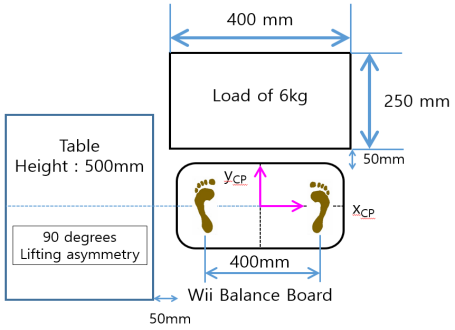
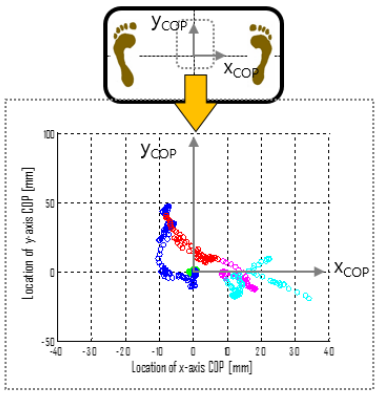
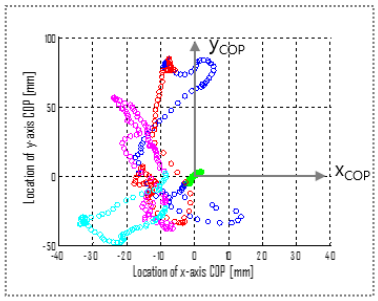


Fig. 2. A schematic drawing of the experimental setup, showing the 0 and 90 degree asymmetry condition.



(a) Results of the COP location for one of Group 1.



(b) Results of the COP location for one of Group 2.

Fig. 3. Results of COP location during the asymmetric lifting according to each phase.

measure the COP location. It is well known that the WBB has become a proven tool for assessing COP location though originally designed as a video game controller [4].

3. Results

Fig. 3 shows results of COP location during the asymmetric lifting according to each phase. Green data are for phase 1, blue data are for phase 2, red data for phase 3, and pink data are for phase 4, respectively. In this experiment, we would like to focus on pink data for phase 4. In spite of same condition to move the 18kg load to the left side, we found that COP locations of Group 1 were the right side, however those of Group 2 were the left side during the phase 4.

Fig. 4 shows results of averaged COP locations during the phase 4 to rotate the load. Blue data represent results of Group 1, and red data represent results of Group 2, respectively. Two larger colored circles indicate the each average of two different groups.

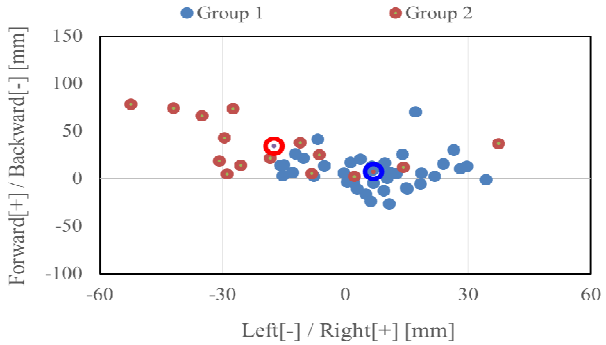


Fig. 4. Results of averaged COP locations during the phase 4 to rotate the load.

As a result, we could see that Group 1 showed the different COP location during the rotation with the comparison of Group 2.

4. Discussion

We discussed the reason why this difference of averaged COP locations during the phase 4 came from the different pelvis location. When participants rotate the load to the left side while lifting, the left covariance of COP location means the closer boundary of allowable region, and the right covariance means the larger margin of stability for allowable region. It is well known that according to the difference of trunk angle, the center of gravity (COG) has the changed value. Through the difference of COG location, the COP location can be also changed [5]. Thus, we could say that the COP location during the rotation was dependent on the pelvis location, and the posture of Group 1 was much safer than that of Group 2.

5. Conclusion

We analyzed the COP location during the asymmetric lifting between Group 1 and 2, and we found that Group 1 showed the different COP location during the rotation with the comparison of Group 2. We discussed the reason why this difference of averaged COP locations came from the different pelvis location in order to keep the good posture and reduce forces on lumbar spine.

References

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