The influence of load carriage weight and position during dynamic standing on a Dynamic Support Surface

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Key words: *dynamic unstable surface, load carriage, anterior position, posterior position*

1. Introduction

Load carriage is a normal weighted carry method used in many fields. It is established that could raise the risk of injuries, muscle strain and joint problems [1]. Chow et al. [2] indicated that a load carriage carried anteriorly might be responsible for postural changes. The weighted carriage is considered that could induce postural imbalance whether static and dynamic conditions due to shifting the posterior and superior the combined centre of mass of weighted carriage system (backpack plus individual). However, current studies have researched the load carriage on static balance and gait analysis. Very few studies have investigated the load carriage with other balance measurement. Moreover, load carriage in anterior position has been relatively unexplored. This study is to explore the trajectory of the COP and the distribution of plantar pressure in load carriage when maintaining an upright standing posture on a dynamic support surface with continuous periodical multidirectional perturbations.

2. Methods

A total of 20 young healthy males (Age: 25±2.1, Height: 176±2.3 cm, Mass: 64±5.5 kg, BMI: 22.42±2.01) participated in this study. All participants were free of pain and injury.

The six degrees of freedom（6-DOF) transportation vibration platform (MTD 6.0, TARCH, Wuhan, China) was used in this study, which consists of a fixed base, six servo valves, six pistons and a movable platform (diameter 2 m). The movable platform can move in three linear movements (lateral, longitudinal, and vertical), three rotations (pitch, roll, and yaw), and any combination movements in space.

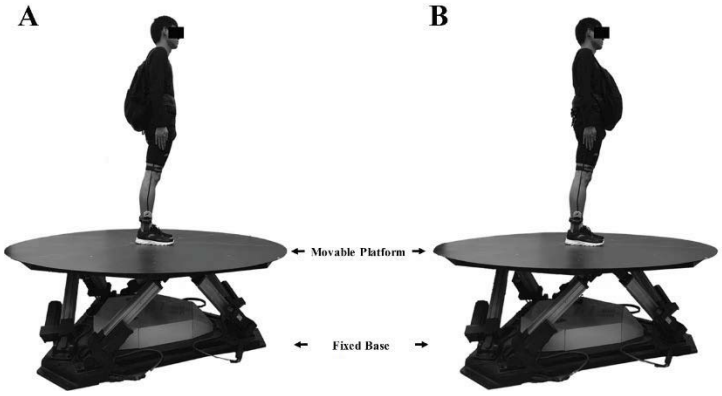

Fig. 1. Structure of the 6-DOF transportation movable platform

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The weight of load was set as 0%, 10%,20% and 30% BW (body weight) of the individual subject. Load of carriage were sports bag and sands inside. Participants were unified to wear a pair of running tights and lightweight sports shoes. Before the test, participants adjusted the backpack to feel comfortable. Each participant performed on the 6-DOF platform for each carriage loading condition in anterior (Fig.1-A) and posterior positions (Fig.1-B) respectively (selected randomly).

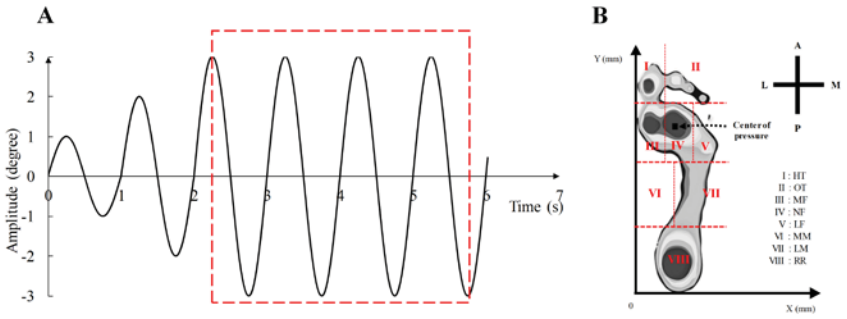

Fig.2. Continuous sinusoidal translation and the mask definition of the plantar area

6-DOF transportation vibration platform is undergoing continuous sinusoidal translation. The amplitude of the platform used a sine wave with frequency of amplitude 3 and 1 rad/s ($y = 3\sin 2\pi x$) (Fig.2-A). The PEDAR insole system (Novel, GmBH, Munich, Germany) was used to measure the trajectory of the centre of pressure (COP) and plantar pressure distribution. The plantar surface of the foot was divided into eight areas based on the anatomy of the foot (Fig.2-B).

3. Results

The mean position of the COP transfer to the forefoot during BW loads increasing. In addition, load carriage in a posterior position indicated an increasing peak pressure and pressure-time integral in all areas except toes with the increasing BW loads. Among the different BW loads, the increasing or decreasing tendency in 20%-30% BW loads was different from 0%-20% BW loads.

4. Conclusion

During the load carriage in a different position, the backpack is not advisable with a load corresponding to 20% of BW or more. The findings of this study suggest that both anterior and posterior load carriage leads to high plantar pressure and movement of COP, and posterior position is predisposed to a higher risk of foot injury than anterior position. Furthermore, the backpack has deleterious effects even with lighter loads.

References

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